INORGANIC CHEMISTRY

TARGET CSIR NET

PREVIOUS YEAR QUESTION'S

QUANTA
CHEMISTRY CLASSES

Address -"Quanta Chemistry Classes, 50 Mall Road, near GTB nagar metro station, Gate no 3,
Kingsway Camp, GTB Nagar, New Delhi (110009) INDIA".
Tel.:9990382567, 9717373074, 8285815185
Email: Quantachemistryclasses@gmail.com
Website :www.quantachemistryclasses.com

QUANTA CHEMISTRY
CLASSES

1

Coordination Chemistry

CSIRJUNE 2011

1. $Ni(CN_4)^{2-}$ and $Ni(Cl_4)^{2-}$ complex ions are **:**

   (a) Both diamagnetic.

   (b) Both paramagnetic

   (c) Diamagnetic and paramagnetic respectively

   (d) Antiferromagnetic and diamagnetic respectively

2. According To Crystal Field Theory, Ni^{2+} can two have unpaired electrons in

   (a) Octahedral geometry only
   (b) Square planar geometry only
   (c) Tetrahedral geometry only
   (d) Both octahedral and tetrahedral geometry

3. The term symbol of a molecule with electronic configuration:

   $(1\sigma g)^2\ (1\sigma u)^2\ (2\sigma g)^2\ (2\sigma u)^2\ (1\pi u)^1\ (1\pi u)^1$ is:

   (a) $^1\Sigma_g^+$
   (b) $^3\Sigma_g^-$
   (c) $^1\Sigma_g^-$
   (d) $^3\Sigma_g^+$

4. Consider two redox pairs:

   (1) Cr(II)/Ru(III)
   (2) Cr(II)/Co(III)

   The rate of acceleration in going from a outer-sphere to a inner-sphere mechanism is lower for (1) relative to (2). Its correct explanation is

   (a) HOMO/LUMO are σ* and σ* respectively.
   (b) HOMO/LUMO are σ* and π* respectively.
   (c) HOMO/LUMO are π* and σ*and respectively.
   (d) HOMO/LUMO are π* and π*respectively.

5. The complex $[Mn (H2O)_6]^{+2}$has very light pink colour. The best reason for it is

(a) the complex does not have a charge transfer transition.

(b) d-d transitions here are orbital forbidden but spin allowed.

(c) d-d transitions here are orbital allowed but spin forbidden.

(d) d-d transitions here are both orbital forbidden and spin forbidden.

6. The correct order of LMCT energies is:

(a) $MnO_4^-<CrO_4^{2-}<VO_4^{3-}$ (b) $MnO_4^->CrO_4^{2-}>VO_4^{3-}$

(c) $MnO_4^->CrO_4^{2-}<VO_4^{3-}$ (d) $MnO_4^-<CrO_4^{2-}>VO_4^{3-}$

7. For the complexes

(A) $[Ni(H_2O)_6]^{+2}$ (B) $[Mn(H_2O)_6]^{+2}$ (C) $[Cr(H_2O)_6]^{+3}$ (D) $[Ti(H_2O)_6]^{+3}$

the ideal octahedral geometry will not be observed in

(a) (A) and (D) (b) (C) and (D) (c) (B) only (d) (D) only

8. The possible J values for ^3D term symbol are

(a) 2 (b) 3 (c) 4 (d) 5

9. Which of the following compound show a charge-transfer band?

(a) Lanthanum nitrate. (b) Ceric ammonium nitrate

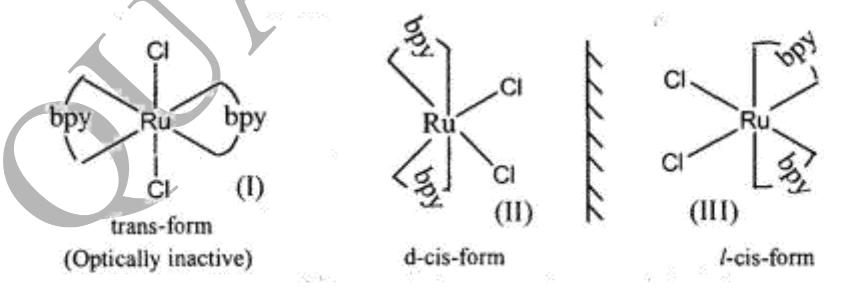
(c) Manganese (II) acetate (d) Copper (II) sulphate pentahydrate

10. Cis and trans complexes of the type $[PtA^2X^2]$ are distinguished by

(a) Chromyl chloride test (b) Carbylamine test

(c) Kurnakov test (d) Ring test

11. The number of possible isomers for $[Ru(bpy)_2Cl_2]$ is (bpy = 2,2′- bipyridine)



(a) 2 (b) 3 (c) 4 (d) 5

CSIR DEC 2011

12. The term symbol for the ground state of nitrogen atoms is

(a) $^3P_0$ (b) $^4P_{3/2}$ (c) $^1P_1$ (d) $^4S_{3/2}$

13. The complex that absorbs light of shortest wavelength is

(a) $[CoF_6]^{3-}$ (b) $[Co(H_20)_6]^{3+}$ (c) $[Co(NH_3)_6]^{3+}$ (d) $[Co(ox)_3]^{3-}$ (ox=$C_2O_4^{2-}$)

14. Green coloured $Ni(PPh_2Et)_2Br_2$, has a magnetic moment of 3.20 B.M. The geometry and the number of isomers possible for the complex respectively, are

(a) Square planar and one (b) Tetrahedral and one

(c) Square planar and two (d) Tetrahedral and two

15. Observe the following electronic transition of a diatomic molecule.

(a) $^1\Sigma^+_g \rightarrow {}^3\Sigma^+_g$ (b) $^1\Sigma^+_u \rightarrow {}^1\Sigma^+_g$ (c) $^1\Delta_u \rightarrow {}^1\Sigma^+_g$ (d) $^1\pi_g \rightarrow {}^1\Sigma^+_u$

The allowed transitions are

(a) (A) and (C) only (b) (B) and (D) only

(c) (A), (B) and (C) only (d) (A). (C) and (D) only

16. The electronic spectrum of $[CrF_6]^{3-}$ shows three bands at 14, 900 cm^{-1} , 22400 cm^{-1} and 34, 800 cm^{-1}. The value of Δ_o in this case is:

(a) 5,500 cm^{-1} (b) 14,900 cm^{-1} (c) 22,400 cm^{-1} (d) 34,800 cm^{-1}

17. A true statement about base hydrolysis of $[Co(NH_3)_5Cl]^{+2}$ is:

(a) It is a first order reaction

(b) The rate determining step involves the dissociation of chloride in $[Co(NH_3)_4(NH_2)Cl]^+$

(c) The rate is independent of the concentration of the base.

(d) The rate determining step involves the abstraction of a proton from $[Co(NH_3)_5Cl]^{+2}$

18. The correct order of d-orbital splitting in a trigonal bipyramidal geometry is:

(a) $d_{z^2} > d_{xz} > d_{x^2-y^2}, d_{xy}$ (b) $d_{xz}, d_{yz} > d_{x^2-y^2}, d_{xy} > d_{z^2}$

(c) $d_{x^2-y^2}, d_{xy} > d_{z^2} > d_{xz}, d_{yz}$ (d) $d_{z^2} > d_{x^2-y^2} > d_{xy} > d_{xz}, d_{yz}$

19. For the following outer sphere electron transfer reactions.

$[Co(NH_3)_6]^{+2} + [Co^*(NH_3)_6]^{+3} \rightarrow [Co(NH_3)_6]_{+3} + [Co^*(NH_3)_6]^{+2}$

$[Ru(NH_3)_6]^{+2} + [Ru^*(NH_3)_6]^{+3} \rightarrow [Ru(NH_3)_6]^{+3} + [Ru^*(NH_3)_6]^{+2}$

the rate constants are 10 $M^{-1}s^{-1}$ and 8.2 × 10 $M^{-1}s^{-1}$ respectively. This difference in the rate constantsis due to

(a) A change from high spin to low spin in Co* and high spin to low spin in Ru.

(b) A change from high spin to low spin in Co* and low spin to high spin Ru*.

(c) A change from low spin to high spin in Co* and the low spin state remains unchanged in Ru.

(d) A change from low spin to high spin in Co* and high spin to low spin in Ru*.

20. The coordination number and geometry of cerium in $[Ce(NO_3)_6]^{-2}$ are respectively,

(a) 6 and octahedron
(b) 6 and trigonal prism
(c) 8 and cubic
(d) 12 and icosahedron

CSIR JUNE 2012

21. As a ligand Cl- is:

(a) Only a σ –donor
(b) Only π donor
(c) Both a σ -donor and π –donor
(d) A σ -donor and a σ –acceptor

22. The correct d-electron configuration showing spin-orbit coupling is

(a) $t^4_{2g}\ e^2_g$
(b) $t^6_{2g}\ e^0_g$
(c) $t^4_{2g}\ e^0_g$
(d) $t^3_{2g}\ e^2_g$

23. The nucleophilic attack on olefins under mild conditions:

(a)Is always facile

(b)Is more facile than electrophilic attack on olefins

(c) Is facile for electron-rich olefins

(d) Requires activation by coordination to metal.

24. The number of spin-allowed ligand field transitions for octahedral Ni(II) complexes with $^3A_{2g}$, ground state is:

(a) Two
(b) Three
(c) One
(d) Four

25. The number of microstates for d^5 electron configuration is:

(a) 21×6^3
(b) 14×6^3
(c) 7×6^2
(d) 28×6^3

26. The set of allowed electronic transitions among the following is:

(A) $^4\Sigma \rightarrow {}^2\Pi$ (B) $^3\Sigma \rightarrow {}^3\Pi$ (C) $^1\Delta \rightarrow {}^1\Delta$ (D) $^2\Pi \rightarrow {}^2\Pi$ (E) $^3\Sigma \rightarrow {}^3\Delta$

(a) A, B, E
(b) A, C, E
(c) B, C, D
(d) C, D, E

CSIR DEC 2012

27. In $[Mo_2(S_2)_6]^{-2}$, cluster the number of bridging S_2^{-2} and coordination number of Mo respectively, are

(a) 2 and 8
(b) 2 and 6
(c) 1 and 8
(d) 1 and 6

28. The light pink color of $[Co(H_2O)_6]^{+2}$and the deep blue color of $[CoCl_4]^{-2}$ are due to

(a) MLCT transition in the first and d-d transition in the second

(b) LMCT transition in both

(c) d-d transitions in both.

(d) d-d transition in the first and MLCT transition in the second.

29. The number of possible isomers of $[Ru(PPh_3)_2\ (acac)_2]$(acac = acetylacetonate) is:

(a) 2 (b) 3 (c) 4 (d) 5

30. The total number of Cu-O bonds present in the crystalline copper(II) acetate monohydrate is:

(a) 10 (b) 6 (c) 8 (d) 4

31. The electric dipole allowed transition in a d^2 atomic system is

(a) $^3F \rightarrow {}^1D$ (b) $^3F \rightarrow {}^1P$ (c) $^3F \rightarrow {}^3D$ (d) $^3F \rightarrow {}^3P$

32. Coordination number of "C" in Be_2C_3 whose structure is correlated with that of CaF_2 is:

(a) 2 (b) 4 (c) 6 (d) 8

33. In the solid state, the $CuCl_5$ ion has two types of bonds. These are

(a) Three long and two short (b) Two long and three short

(c) One long and four short (d) Four long and one short

34. The correct spinel structure of Co_3O_4 is:

(a) (Co^{+2}) t $(2CO^{+3})$ o O_4 (b) (Co^{+2}) t $(2Co^{+3}\ Co^{+3})$ o O_4

(c) $(Co^{+2}\ Co^{+3})$ t (Co^{+3}) o O_4 (d) $(2Co^{+3})$ t (Co^{+2}) o O_4

35. The platinum complex of NH_3 and Cl^-ligands is an anti-tumour agent. The correct isomeric formula of the complex and its precursor are:

(a) cis-$Pt(NH_3)_2Cl_2$ and $PtCl_4^{2-}$

(b) trans-$Pt(NH_3)2Cl_2$ and $PtCl_4^{2-}$

(c) cis-$Pt(NH_3)\ _2Cl_2$ and $Pt(NH_3)_4^{2-}$

(d) trans-$Pt(NH_3)\ _2Cl_2$ and $Pt(NH_3)_4^{2-}$

36. One of the excited states of Ti has the electric configuration [Ar] $4s^2\ 3d^1\ 4p^1$. The number of microstates with zero total spin (S) for this configuration is

(a) 9 (b) 15 (c) 27 (d) 60

37. The rate of exchange of OH_2 present in the coordination sphere by $^{18}OH_2$ of, (i)$[Cu(OH_2)_6]^{2+}$ (ii) $[Mn(OH_2)_6]^{2+}$ (iii) $[Fe(OH_2)]_6^{2+}$ (iv) $[Ni(OH_2)]_6^{2+}$ follows an order

(a) (i)>(ii)> (iii)> (iv) (b) (i)>(iv)> (iii) > (ii)

(c) (ii) >(iii) >(iv) > (i) (d) (iii)> (i)>(iv) >(ii)

CSIR JUNE 2013

38. The reaction of $Pt(NH_3)_4^{2-}$ with two equivalents of NH_3 produces

(a) cis-$[Pt(NH_3)_2Cl_2]$

(b) trans –$[Pt(NH_3)_2Cl_2]$

(c) both cis-$[Pt(NH_3)_2Cl_2]$ and trans –$[Pt(NH_3)_2Cl_2]$

(d) cis –$[Pt(NH_3)_2Cl_4]^{2-}$

39. The electronic transition responsible for the colour of the transition metal ions is

(a) $d_\pi \rightarrow d_\sigma$ (b) $d_\pi \rightarrow d_\sigma^*$ (c) $d_\pi \rightarrow d_\pi^*$ (d) $d_\sigma \rightarrow d_\pi^*$

40. The Mulliken symbols for the spectroscopic states arising from the free-ion term F are

(a) $T_{2g} + E_g$ (b) $T_{1g} + T_{2g} + T_{1u}$ (c) $T_{1g} + T_{2g} + A_{2g}$ (d) $A_{1g} + T_{2g} + T_{1g}$

41. Which of the pairs will generally result in tetrahedral coordination complexes, when ligands are Cl^- or OH^-.

(A) Be(II), Ba(II) (B) Ba(II), Co(II)

(C) Co(II), Zn(II) (D) Be(II), Zn(II)

(a) A and B (b) B and C (c) C and D (d) A and D

42. Silica gel contains $[Co(Cl_4)]^{2-}$ as an indicator. When activated , silica gel becomes dark blue while upon absorption of moisture, its colour changes to pale pink This is because,

(a) Co (II) changes its coordination from tetrahedral to octahedral.

(b) Co(II) changes its oxidation state to Co(III)

(c) Tetrahedral crystal field splitting is NOT equal to octahedral crystal field splitting

(d) Co(II) forms kinetically labile while Co(III) forms kinetically inert complexes.

43. Intense band at 15000 cm-1 in the UV-visible spectrum of $[Bu_4N]_2 Re_2 Cl_8$ is due to the Transition

(a) $\pi \rightarrow \pi^*$ (b) $\delta \rightarrow \delta^*$ (c) $\delta \rightarrow \pi^*$ (d) $\pi \rightarrow \delta^*$

44. Identify the order representing increasing π -acidity of the following ligands C_2F_4, NEt_3, CO and C_2H_4

(a) $CO < C_2F_4 < C_2H_4 < NEt_3$ (b) $C_2F_4 < C_2H_4 < NEt_3 < CO$

(c) $C_2H_4 < NEt_3 < CO < C_2F_4$ (d) $NEt_3 < C_2H_4 < C_2F_4 < CO$

45. The species with highest magnetic moment (spin only value) is

(a) VCI_6^{4-} (b) $(\eta^5C_5H_5)_2Cr$ (c) $[Co(NO_2)_6]^{3-}$ (d) $[Ni(EDTA)]^{2-}$

46. Three bands in the electronic spectrum of $[Cr(NH_3)_{6,}]^{3+}$ are due to the following transitions

(A) $^4A_{2g} \rightarrow {}^4T_{1g}$ (B) $^4A_{2g} \rightarrow {}^4T_{2g}$ (C) $^4A_{2g} \rightarrow {}^2E_g$

Identify the correct statement about them

(a) Intensity of (A) is lowest (b) Intensity of (C) is lowest

(c) Intensities of (A), (B) and (C) are similar (d) Intensities of (B) and (C) are similar

47. The Δt of the following complexes

(A) $[Co(Cl_4)]^{2-}$ (B) $[Co(Br_4)]^{2-}$ (C) $[Co(NCS_4)]^{2-}$

Follows the order

(a) C > A > B (b) A > B > C (c) B > A > C (d) C > B > A

CSIR DEC 2013

48. An octahedral metal ion M^{+2} has magnetic moment of 4.0 B.M. The correct combination of metal ion and d-electron configuration is given by

(a) Co^{2+}, $t^5_{2g}\ e^2_g$ (b) Cr^{2+}, $t^4 2_g\ e^2_g$ (c) Mn^{2+}, $t^3_{2g}\ e^1_g$ (d) Fe^{2+}, $t^4_{2g}\ e^2_g$

49. For an electronic configuration of two non-equivalent π electronics $[\pi^1, \pi^1]$ which of the Following terms is not possible?

(a) $^1\Sigma$ (b) $^3\Sigma$ (c) $^3\Delta$ (d) $^3\phi$

50. Among the following, the correct combination of complex and its color is

Complex	Colour
(a) $[Co(CN_4)]^{2-}$	Red
(b) $[Co(Cl_4)]^{2-}$	Orange
(c) $[Co(CNS)_4]^{2-}$	Blue
(d) $[Co(F_4)]^{2-}$	Yellow

51. $MnCr_2O_4$ is likely to have a normal spinel structure because

(a) Mn^{2+} will have a LFSE in the octahedral site whereas the Cr will not

(b) Mn is $^{+2}$ oxidation state and both the Cr are in^{+3} oxidation state.

(c) Mn is $^{+3}$ oxidation state and I Cr is in^{+2} and the other is in $^{+3}$ state.

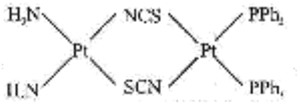
(d) Cr^{3+} will have a LFSE in the octahedral site whereas the Mn^{2+} ion will not.

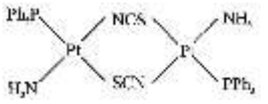
52. Compounds $K_2Ba[Cu(NO_2)_6]$ (A) and $Cs_2Ba[Cu(NO_2)_6]$ (B) exhibit tetragonal elongation and tetragonal compression, respectively. The unpaired electron in A and B are found respectively, in orbitals

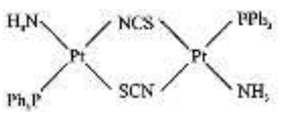
(a) d_{z^2} and d x^2-y^2, (b) d x^2-y_2 and d_{z^2}

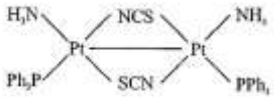
(c) d_{z^2} and d_{z^2} (d) d x^2-y^2 and d x^2-y^2

53. The most appropriate structure for the complex $[Pt_2(NH_3)_2(NCS)_2(PPh_3)_2]$ is

(a)


(b)


(c)


(d)


CSIR JUNE 2014

54. In bis(dimethylglyoximato)nickel(II), the number of Ni-N, Ni-O and intramolecular hydrogen bond(s)respectively are

(a) 4,0 and 2 (b) 2, 2 and 2 (c) 2, 2 and 0 (d) 4, 0 and 1

55. $NiBr_2$ reacts with (Et)(Ph_2)P at -78°C in CS_2 to give red compound 'A', which upon standing at room temperature turns green to give compound, 'B' of the same formula. The measured magnetic moments of 'A' and 'B' are 0.0 and 3.2 BM, respectively. The geometries of 'A' and 'B' are

(a) square planar and tetrahedral (b) tetrahedral and square planar

(c) square planar and octahedral (d) tetrahedral and octahedral

56. If L is a neutral mono-dentate ligand, the species, $[AgL_4]^{2+}$, $[AgL_6]^{2+}$ and $[AgL_4]^{3+}$respectively are

(a) Paramagnetic, paramagnetic and diamagnetic (b) Paramagnetic, diamagnetic and paramagnetic

(c) Diamagnetic, paramagnetic and diamagnetic (d) Paramagnetic, diamagnetic and diamagnetic

57. $[CoL_6]^{3+}$ is red in colour whereas $[CoL'_6]^{3+}$ is green. L. and L' respectively corresponds to,

(a) NH_3 and H_2O (b) NH_3 and 1, 10-phenanthroline

(c) H_2O and 1, 10-phenanthroline (d) H_2O and NH_3

58. In its electronic spectrum, $[V(H_2O)_6]^{3+}$exihibits two absorption bands, one at 17,800 (v_1) and the second at 25, 700 (v_2) cm. The correct assignment of these bands, respectively, is

(a) $v_1 = {}^3T_1g\ (F) \rightarrow {}^3T_2g\ (F)$, $V_2 = {}^3T_1g\ (F) \rightarrow {}^3T_1g\ (P)$

(b) $v_1 = {}^3T_1g\ (F) \rightarrow {}^3T_1g\ (P)$, $V_2 = {}^3T_1g\ (F) \rightarrow {}^3T_2g\ (P)$

(c) $v_1 = {}^3A2g \rightarrow {}^3T_1g\ (F\ )$, $V_2 = {}^3A_{2g} \rightarrow {}^3T_2g\ (F)$

(d) $v_1 = {}^3A2g \rightarrow {}^3T_2g\ (F)$, $V_2 = {}^3A_{2g} \rightarrow {}^3T_1g$ ((F)

59. The term symbol that is NOT allowed for the np^2configuration is

(a) ^1D (b) ^3P (c) ^1S (d) ^3D

60. Reaction of $[Ru(NH_3)_5(\text{isonicotinamide})]^{+3}$ with $[Cr(H_2O)_6]$ +3 occurs by inner sphere mechanism and rate of the reaction is determined by dissociation of the successor complex. It is due

(a) Inert ruthenium birdged to inert chromium centre

(b) Inert ruthenium bridged to labile chromium centre

(c) Labile ruthenium bridged to inert chromium centre

(d) Labile ruthenium bridged to labile chromium centre

61. Consider the second order rate constants for the following outer-sphere electron transfer

$[Fe(H_2O)_6]^{+3}$ / $[Fe(H_2O)_6]^{+2}$ 4.0 M^{-1} sec^{-1}

$[Fe(phen)^3]^{+3}$ /$[Fe(phen)^3]^{+3}$ 3.0 x10^7 M^{-1}

(phen= 1, 10-phenanthroline)

The enhanced rate constant for the second reaction is due to the fact that

(a) The 'phen' is a π-acceptor ligand that allows mixing of electron donor and acceptor orbitals that enhances the rate of electron transfer

(b) The phen' is a π -donor ligand that enhances the rate of electron transfer

(c) The 'phen' forms charge transfer complex with iron and facilitates the eletron transfer

(d) The 'phen' forms kinetically labile complex with iron and facilitates the electron transfer.

62. A 1: 2 mixture of $Me_2NCH_2CH_2CH_2PPh_2$ and KSCN with $K_2[PdCl_4]$ gives a square planar complex A. Identify the correct pairs of donor atoms trans to each other in complex A from the following combinations.

(a) P, N (b) N, S (c) P, S (d) N, N

63. Identify the correct statement about $[Ni(H_2O)_6]^{+2}$ and $[Cu(H_2O)_6]^{+2}$

(a) All Ni-O and Cu-O bond lengths of individual species are equal

(b) Ni-O(equatorial) and Cu-O(equatorial)

(c) All Ni-O bond lengths are equal whereas Cu-O (equatorial) bonds are shorter than CuO(axial) bonds

(d) All Cu-O bond lengths are equal whereas Ni-O(equatorial) bonds are shorter than NiO(axial)bonds

64. Reaction of nitrosyltetrafluoroborate to Vaska's complex gives complex A with angle M-NO=124°. The complex A and its N-O stretching frequency are, respectively

(a) $[IrCl(CO)(NO)(PPh_3)_2]BF_4$, 1620 cm^{-1}

(b) $[IrCl(CO)(NO)_2(PPh_3)](BF_4)_2$, 1730 cm^{-1}

(c) $[IrCl(CO)(NO)_2(PPh_3)](BF_4)_2$ 1520 cm^{-1}

(d) $[IrCl(CO)(NO)(PPh_3)_2]$, 1820 cm^{-1}

CSIR DEC 2014

65. The S and L values for ^{15}N atom respectively, are

(a) 1/2 and 1 (b)1/2 and 0 (c) 1 and 0 (d) 3/2 and 0

66. In the following reaction $[PtCl_4]^{-2}$ +NO_2^-, is →A + NH_3 →B , compound B is

(a) trans-$[PtCl_2 (NO_2) (NH_3)]^-$ (b) cis-$[PtCl(NO_2)(NH_3)]^-$

(c) trans-$[PtCl_2(NH_3)_2]$ (d) cis-$[PtCl_3(NO_2)_2]^{-2}$

67. The number of stereoisomers of trans-[$CoCl_2$(triethylenetetraamine)] Br is

(a) One (b) Two (c) Three (d) Four

68. An aqueous solution of $[Mn(H_2O)_6]^{+2}$ complex is pale pink in colour. The probable reasons for it are

(A) Presence of $^6A_{1g}$ ground state (B) Disallowed transition by spin selection rule

(C) Presence of $^2T_{2g}$ ground state (D) Charge transfer transition

The correct answer is

(a) A and B (b) A and C (c) B and C (d) C and D

69. Base hydrolysis of $[CoCl(NH_3)_5]^{+2}$ is an overall second order reaction, whereas that of $[Co(CN)]^{-3}$ is of first order. The rates depend in both cases solely on the concentrations of the cobalt complex. This may be due to

(A) Presence of ionizable proton in $[CoCl(NH_3)_5]^{+2}$ but not in $[Co(CN)_6]^{-3}$,

(B) SN^1_{CB} mechanism in the case of $[CoCl(NH_3)_5]^{+2}$ only

(C) SN^1_{CB} mechanism in the case of $[Co(CN)_6]^{-3}$, only

(D) SN^1_{CB} mechanism in both the complexes

Correct explanation(s) is/are

(a) A and B (b) A and C (C) B only (d) A and D

70. The configuration [Ne] $2p^1$ $3p^1$ has a ^3D term. Its levels are

(a) $^3D_{3/2}$, $^3D_{1/2}$ (b) $^3D_{5/2}$, $^3D_{3/2}$, $^3D_{1/2}$ (c) $^3D_3$, $^3D_2$, $^3D_1$ (d) $^3D_3$, $^3D_2$, $^3D_1$, $^3D_0$

71. The spin-only magnetic moment and the spectroscopic ground state term symbol of manganese center in $[MnF_6]^{-3}$ ion respectively, are

(a) 4.9 BM and ^5D (b) 4.9 BM and ^4F (c) 3.9 BM and ^3D (d) 4.9 BM and ^3F

72. The three dimensional structure of compound $[Co(Co(NH_3)_4(OH)_2)_3]Br_6$, has

(a) Twelve Co-O and twelve Co-N bonds (b) Ten Co-O and ten Co-N bonds

(c) Fourteen Co-O and ten Co-N bonds (d) Twelve Co-O and ten Co-N bonds

73. The spin-only and spin plus orbital magnetic moments of $[CrCl_6]^{-3}$ are

(a) 3.87 BM and 5.20 BM (b) 2.84 BM and 5.20 BM

(c) 3.87 BM and 6.34 BM (d) 2.84 BM and 6.34 BM

CSIR JUNE 2015

74. In transition metal phosphine ($M-PR_3$) complexes, the back-bonding involves donation of electrons from

(a) $M(t_{2g}) \rightarrow PR_3(\sigma^*)$ (b) $M(t_{2g}) \rightarrow PR_3(\pi^*)$ (c) $M(e_g) \rightarrow P(d)$ (d) $PR_3(\pi) \rightarrow M(t_{2g})$

75. The electric-dipole allowed transition among the following is

(a) $^3S \rightarrow {}^3D$ (b) $^3S \rightarrow {}^3P$ (c) $^3S \rightarrow {}^1D$ (d) $^3S \rightarrow {}^1F$

76. The lowest energy-state of an atom with electronic configuration ns^1np^1has the term symbol

(a) $^3P_1$ (b) $^1P_1$ (c) $^3P_2$ (d) $^3P_0$

77. Match the complexes given in column I with the electronic transitions (mainly responsible for their colours) listed in column II

Column-I	**Column-II**
(I) Fe(II)-protoporphyrin IX	(A) $\pi \rightarrow \pi^*$
(II) $[Mn(H_2O)_6]Cl_2$	(B) spin allowed d-d
(III) $[Co(H_2O)_6]Cl_2$	(C) spin forbidden $d \rightarrow d$
	(D) $M\rightarrow L$ charge transfer

The correct answer is:

(a) I-A, II-C and III-B (b) I-D, II-B and III-C

(c) 1-A, II-C and III-D (d) I-A, II-B and III-C

78. Among the complexes, (A) $K_4[Cr(CN)_6]$, $K_4[Fe(CN)_6]$, (C) $K_3[Co(CN)_6]$, (D)$K_4[Mn(CN)_6]$,and Jahn-Teller distortion is expected in

(a) A, B and C (b) B, C and D (c) A and D (d) B and C

79. The complex [Fe $(phen)_2(NCS)_2$] (phen 1,10-phenanthroline) shows spin cross-over behaviour CFSE and at μ_{eff} 250 and 150K, respectively are

(a) $0.4\Delta_0$, 4.90 BM and 2.4Δ,, 0.00 BM (b) $2.4\Delta_0$, 2.90 BM and 0.4Δ, 1.77 BM

(c) $2.4\Delta_0$, 0.00 BM and 0.4Δ, 4.90 BM (d) $1.2\Delta_0$, 4.90 BM and 2.4Δ. 0.00 BM

CSIR DEC 2015

80. The term symbol for the first excited state of Be with the electronic configuration $1s^2\ 2s^1\ 3s^1$ is.

(a) $^3S_1$ (b) $^3S_0$ (c) $^1S_0$ (d) $^2S_{1/2}$

81. The oxidizing power of $[CrO_4]^{2-}$, $[MnO_4]^{2-}$ and $[FeO_4]^{2-}$ follows the order

(a) $[CrO_4]^{2-} < [MnO_4]^{2-} < [FeO_4]^{2-}$ (b) $[FeO_4]^{2-} < [MnO_4]^{2-} < [CrO_4]^{2-}$

(c) $[MnO_4]^{2-} < [FeO_4]^{2-} < [CrO_4]^{2-}$ (d) $[CrO_4]^{2-} < [FeO_4]^{2-} < [MnO_4]^{2-}$

82. Using crystal field theory, identify from the following complex ions that shows same μ_{eff} (spin only) values

(A) $[CoF_6]^{3-}$

(B) $[IrCl_6]^{3-}$

(C) $[Fe(H_2O)_6]^{2+}$

(a) A and B (b) B and C (c) A and C (d) A, B and C

83. The correct statement for Mn-O bond lengths in $[Mn(H_2O)_6\ ]^{2+}$, is

(a) all bonds are equal (b) four bonds are longer than two others

(c) two bonds are longer than four others (d) they are shorter than the Mn-O bond in $[MnO_4]^-$

84. Identify the complex ions in sequential order when ferroin is used as an indicator in the titration of iron(II) with potassium dichromate, (phen = 1, 10-phenathroline)

(a) $[Fe(phen)_3]^{2+}$ and $[Fe(phen)_3]^{3+}$ (b) $[Fe\ (phen)_3]^{3+}$ and $[Fe(phen)_3]^{2+}$

(c) $[Fe(CN)_6]^{4-}$ and $[Fe(CN)_6]^{3-}$ (d) $[Fe(CN)_6]^{3-}$ and $[Fe(CN)_6]^{4-}$

85. The formation constant for the complexation of M^+ (M= Li, Na, K and Cs) with cryptand, C_{222} follows the order

(a) $Li^+ < Cs^+ < Na^+ < K^+$ (b) $Li^+ < Na^+ < K^+ < Cs^+$

(c) $K^+ < Cs^+ < Li^+ < Na^+$ (d) $Cs^+ < K^+ < Li^+ < Na^+$

86. $[MnO_4]^-$ is deep purple in colour whereas $[ReO_4]^-$ is colourless. This is due to greater energy required for

(a) d-d transitions in the Re compound compared to the Mn compound

(b) d-d transitions in the Mn compound compared to the Re compound

(c) charge transfer from O to Re compared to O to Mn

(d) charge transfer from O to Mn compared to O to Re

87. The correct statement about the substitution reaction of $[Co(CN)_5Cl]^{3-}$ with OH- to give $[Co(CN)_5(OH)]^{3-}$is,

(a) it obeys first order kinetics

(b) its rate is proportional to the concentration of both the reactants

(c) it follows the SN^1_{CB} mechanism

(d) its rate is dependent only on the concentration of $[OH]^-$

88. Aqueous Cr^{+2} effects one electron reduction of $[Co(NH_3)_5Cl]^{+2}$ giving compound Y. Compound Y undergoes rapid hydrolysis. Y is,

(a) $[Co(NH_3)_5]^{+2}$ (b) $[Co(NH_3)_5(OH)]^+$ (c) $[Co(NH_3)_4(OH)_2]$ (d) $[Cr(H_2O)_5Cl]^{+2}$

89. Choose the correct statements about Tanabe-Sugano diagrams

(A) E/B is plotted against Δ_0/B.

(B) The zero energy is taken as that of the lowest term

(C) Terms of the same symmetry cross each other

(D) Two terms of the same symmetry upon increases of ligand field strength bend apart from each Other.

Correct answer is

(a) A and B (b) A and C (c) A, B and D (d) A, B, C and D

90. Three electronic transitions at 14900, 22700 and 34400 cm^{-1} are observed in the absorption spectrum of $[CrF_6]^{-3}$, The Δ0 value (in cm^{-1}) and the corresponding transition are

(a) 7800 and ${}^4A_{2g} \rightarrow {}^4T_2g$ (b) 14900 and ${}^4A_{2g} \rightarrow {}^4T_2g$

(c) 14900 and ${}^4T_1g \rightarrow {}^4T_1g$ (F) (d) 7800 and ${}^4T_{2g} \rightarrow {}^3T_{1g}$ (F)

91. Possible term symbol(s) of the excited states of Na atom with the electronic configuration $[1s^2 2s^2 2p^6 3p^1]$ is/are

(a) ${}^2S_{1/2}$ (b) ${}^2P_{3/2}$ and ${}^2P_{1/2}$ (c) ${}^1S_0$ and ${}^1P_1$ (d) ${}^3P_0$ and ${}^3P_1$

92. The symmetry-allowed atomic transition among the following is

(a) ${}^3F \rightarrow {}^1D$ (b) ${}^3F \rightarrow {}^3D$ (c) ${}^3F \rightarrow {}^1P$ (d) ${}^3F \rightarrow {}^3P$

CSIR JUNE 2016

93. $[Ni^{II}L_6]^{n+ \text{ or } n-}$ shows absorption bands at 8500, 15400, and 26000 cm^{-1} whereas $[Ni^{II} L'_6]^{n+ \text{ or } n-}$ at 10750, 17500 and 28200 cm^{-1} . L and L' are respectively

(a) OH^{-1} andN_3^{-1} (b) Cl^{-1} and I^{-1}

(c) NCS^{-1} and RCO_2^{-1} (d) H_2O and NH_3

94. The number of microstates present in ^3F-term is

(a) 3 (b) 21 (c) 9 (d) 28

95. Chelate effect is

(a) predominantly due to enthalpy change

(b) predominantly due to entropy change

(c) independent of ring size

(d) due to equal contribution of entropy and enthalpy change

96. The lowest energy term for the d^6configuration is

(a) ^2D (b) ^5D (c) ^1P (d) ^1D

97. The first excited state of hydrogen molecule is

(a) $^1\Sigma_g^+$ (b) $^1\Sigma_u^+$ (c) $^3\Sigma_g^-$ (d) $^3\Sigma_u^+$

98. Complex $[Cr(bipyridyl)_3]^{+3}$, shows red phosphorescence due to transition

(a) $^4T_{2g} \leftarrow {}^4A_{2g}$ (b) $^4T_{1g} \leftarrow {}^4A_{2g}$ (c) $^4A_{2g} \leftarrow {}^2E_g$ (d) $^2E_g \leftarrow {}^4A2g$

99. The complex that shows orbital contribution to the magnetic moment, is

(a) $[Cu(H_2O)_6]^{+2}$ (b) $[Ni(H_2O)_6]^{+2}$ (c) $[Co(H_2O)_6]^{+2}$ (d) $[Cr(H_2O)_6]^{+2}$

100. Paramagnetic susceptibility of the order of 10^{-6} cm^3 mol^{-1} observed for $KMnO^4$ is due to-

(a) random spin alignment (c) paramagnetic impurity

(b) antiferromagnetic exchange interaction (d) temperature independent paramagnetism

101. The room temperature magnetic moment (in BM) for a monomeric Cu(II) complex is greater than 1.73. This may be explained using the expression: [CSIR-JUNE 2016]

(a) $\mu_{eff} = \mu s \left(1 - \frac{\lambda a}{\Delta}\right)$ (b) $\mu_{eff} = \sqrt{n(n+2)}$

(c) $\mu_{eff} = \sqrt{4s(s+1) + (L+1)}$ (d) $\mu_{eff} = g\sqrt{J(J+1)}$

CSIR DEC 2016

102. The HOMO (highest occupied molecular orbital) to LUMO (lowest unoccupied molecular orbital) electronic transition responsible for the observed colours of halogen molecules (gas) is

(a) $\pi^* \rightarrow \sigma^*$ (b) $\pi^* \rightarrow \pi^*$ (c) $\sigma \rightarrow \sigma^*$ (d) $\pi \rightarrow \sigma^*$

103. In the hydrolysis of trans-$[Co(en)_2Cl(A)]^+$if the leaving group is chloride, the formation of cis product is the least, when A is

(a) NO_2^- (b) NCS^- (c) Cl^- (d) OH^-

104. The nephelauxetic parameter β is highest for

(a) Br^- (b) Cl^- (c) CN^- (d) F^-

105. The $^2E_g \leftarrow {}^4A_{2g}$ transition in the electronic spectrum of $[Cr(NH_3)_6]^{+3}$ occurs nearly at

(a) 650 nm (b) 450 nm (c) 350 nm (d) 200 nm

106. For $[Ce(NO_3)_4(OPPh_3)_2]$ from the following

A. Its aqueous solution yellow-orange in B. Coordination number of Ce is ten

C. It shows metal to ligand charge transfer D. It is diamagnetic in nature

The correct answer is

(a) A and B (b) A and C (c) A, B and D (d) B, C and D

107. Consider the following statements for $[FeO_4]^{-4}$

A. It is paramagnetic B. It has T_d symmetry

C. Adopts distorted square planar geometry D. Shows approximately D_{2d} symmetry

The correct answer is

(a) A, B and C (b) A, C and D (c) A and D (d) A and B

108. The spectroscopic ground state term symbols for the octahedral aqua complexes of Mn(II), Cr(III) and Cu(II), respectively, are

(a) ^2H , ^4F and ^2D (b) ^6S, ^4F and ^2D (c) ^2H , ^2H and ^2D (d) ^6S, ^4F and ^2P

109. For OH^- catalysed S_N 1 conjugate base mechanism of $[Co(NH_3)_5Cl]^{+2}$, the species obtained in the first step of the reaction is/are

(a) $[Co(NH_3)_5(OH)]^{+2}$ +Cl^- (b) $[Co(NH_3)_4(NH_2)Cl]^+$ +H2O

(c) $[Co(NH_3)_4(NH_2)]^{+2}$ +CI (d) $[Co(NH_3)_5Cl(OH)]^+$Only

110. In the following redox reaction with an equilibrium constant K = 2.0 × 10^8

$[Ru(NH_3)_6]^{+2}$ +$[Fe(H_2O_6)]^{+3}$ → $[Ru(NH_3)_6]^{+3}$ +$[Fe\ (H_2O)_6]^{+2}$the self exchange rates for oxidant and reductant are 5.0 $M^{-1}s^{-1}$ and 4.0×10^3 $M^{-1}s^{-1}$ respectively.

The approximate rate constant ($M^{-1}s^{-1}$) for the reaction is

(a) 3.16×10^6 (b) 2.0×10^6 (c) 6.32×10^6 (d) 3.16×10^6

111. The correct statement for a Fischer carbene complex is

(a) the carbene carbon is electrophilic in nature

(b) metal exists in high oxidation state

(c) metal fragment and carbene are in the triplet states

(d) CO ligands destabilize the complex

112. The highest molecular orbitals for an excited electronic configuration of the oxygen molecule are $[1\pi g\ ]^1\ [3\sigma u]^1$. A possible molecular term symbol for oxygen with this electronic configuration is

(a) $^1\pi$ (b) $^3\sum$ (c) $^1\Delta$ (d) $^1\sum$

CSIR JUNE 2017

113. CdS , HgS and BiI3 are coloured due to

(a) L→M charge transfer transitions

(b) d→ d electronic transitions

(c) M→L charge transfer transitions

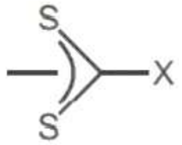
(d) combination of L →M charge transfer and d→d electronic transitions

114. The relative rates of water exchange for the hydrated complexes of

(1) Ni^{+2} (2) V^{+2} and (3) Cr^{3}+ ions follows the trend:

(a) (1) > (2) > (3) (b) (1) < (2) < (3) (c) (1) > (2) < (3) (d) (1) < (2) > (3)

115. Consider the following sulfur donor atom bearing bidentate ligand where X and name of ligands are given in following columns



X	Ligand name
A. NR_2	I. Dithiocarbonate
B. OR	II. Dithiocarbamate
C. O-	III. Xanthate
D. SR	IV. Thioxanthate

Correct match of entries given in two columns is

(a) A-II, B-III, C-I, D-IV (c) A-I, B-II, C-III, D-IV

(b) A-III, B-II, C-IV, D-I (d) A-IV, B-I, C-II, D-III

Q116.A copper (II)complex having distorted octahedral geometry shows an absorption band at 625 nm. Given spin –orbit coupling of the complex as 625cm^{-1}, the μ_{eff} (in B.M) is

(a) 1.73 (b) 1.81 (c) 1.63 (d) 1.93

117. Consider the following statements for octahedral complexes. (a) $[CrF_6]^{-3}$ (b) $[Cr(ox)_3]^{-3}$ and (c)$[Cr(en)_3]^{+3}$

A. their d $\rightarrow$ d transitions are at 14900, 17500, and 21800 cm^{-1}, respectively

B. their spin-only magnetic moments are same

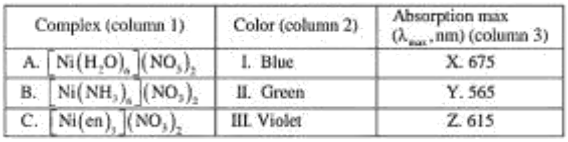
C. two of them have optical isomers

D. all of them show Jahn-Teller distortion

The correct statements are

(a) A, B, and C (b) A, C, and D (c) B, C, and D (d) B and D

118. Match the items in the three columns.



Complex (column 1)	Color (column 2)	Absorption max (λ_{max}, nm) (column 3)
A. $[Ni(H_2O)_6](NO_3)_2$	I. Blue	X. 675
B. $[Ni(NH_3)_6](NO_3)_2$	II. Green	Y. 565
C. $[Ni(en)_3](NO_3)_2$	III. Violet	Z. 615

The correct answer is

(a) A-II-X; B-I-Z; C-III-Y (c) A-III-Y: B-1-Z; C-II-X

(b) A-I-X; B-Il-Y; C-III-Z (d) A-I-X; B-II-Z; C-III-Y

CSIR DEC 2017

119. For the following complexes, the increasing order of magnetic moment (spin only value) is

A. $[TiF_6]^{-3}$ B. $[CrF_6]^{-3}$

C. $[MnF_6]^{-3}$ D. $[CoF6]^{-3}$

(a) D < A < B < C (b) C < A < D < B (c) B ≈ A < D < C (d) A < B < C ≈ D

120. The geometry around Cu and its spin state for K_3CuF_6 and $KCuL_2$, [H_2L= $H_2NCONHCONH_2$], respectively are:

(a) (octahedral, high-spin) and (square planar, low-spin)

(b) (octahedral, low-spin) and (square planar, low-spin)

(c) (trigonal prismatic, high-spin) and (tetrahedral, high-spin)

(d) (trigonal prismatic, low-spin) and (tetrahedral, high-spin)

121. Consider the following statements with respect to the base hydrolysis of $[CoCl(NH_3)_5]$ to $[Co(NH_3)_5(OH)]^{+2}$

A. One of the ammonia ligands acts as a Bronsted acid.

B. The entering group is water.

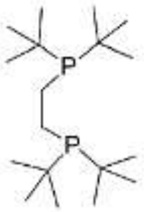
C. A heptacoordinated Co^{+3} species is an intermediate.

The correct statement(s) is/are

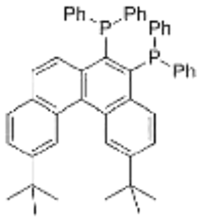
(a) A and B (b) A and C (c) B and C (d) C only

122. Considering the ambidentate behaviour of thiocyananate ion, the most stable structure among the following is

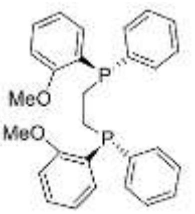
(a)



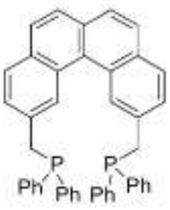
(b)



(c)



(d)



123. For high spin and low spin d^6octahedral complexes (ML_6), the generally observed spin allowed transitions respectively, are

(a) two and one (b) one and two (c) zero and one (d) two and two

124. Br^2 with propanone forms a charge transfer complex and I_2 forms triiodide anion with I^- .
This implies that

(a) both Br_2 and I_2 act as bases (b) both Br_2 and I_2 act as acids

(c) Br_2 acts as an acid and I_2 acts as a base (d) Br_2 acts as a base and I_2 acts an an acid

125. Mismatch among the following is

(a) Sharp transition and fluorescence in lanthanides

(b) Broad bands and d-d transitions

(c) Very high spin-orbit coupling and transition elements

(d) Charge transfer and molar absorptivity of the order of 10^1 L $mol^{-1}cm^{-1}$

CSIR JUNE 2018

126. The total degeneracy of the ground term of Co^{11} (high spin) in octahedral geometry is

(a) 18 (b) 12 (c) 28 (d)9

127. High spin complex of a 3d metal ion M has a magnetic moment of 2.9 B.M. in octahedral coordination environment and 4.1 B.M. in tetrahedral environment. The M ion is

(a) Co^{+2} (b) Ni^{+2} (c) Cu^{+2} (d) Co^{+2}

128. For electronic spectra of K_2CrO_4 (A) and K_2MoO_4(B) the correct combination is

(a) Transition is d-d and λ_{max} has for A < B (b) Transition is LMCT and λ_{max} for A <B

(c) Transition is LMCT and λ_{max} for A > B (d) Transition is MLCT and λ_{max} for A > B

129. The lowest energy state of a $1s^1$ $2s^1$ electronic configuration, according to hund's rule, is

(a) $^3S_0$ (b) $^1S_0$ (c) $^3S_1$ (d) $^1S_1$

130. Consider the following statements:

(A) Cr^{+2} is easier to oxidize than V^{+2} in the gas phase

(B) Cr^{+2} (aq) is a more powerful reducing agent than V^{+2} (aq).

(C) The rate of water exchange for Cr^{+2} (aq) is much faster than for V^{+2}(aq)

The correct statements are

(a) A and B (b) A and C (c) B and C (d) A, B and C

131. Consider the statements A - D regarding equation I-III:

(I) $[Fe(CN)_6]^{-3} + [Co(CN)_5]^{-3} \rightarrow [Fe(CN)_6]^{-4} + [Co(CN)_5]^{-2}$

(II) $[Co(bipy)_3]^{+2} + [Co^* (bipy)_3]^{+3} \rightarrow [Co(bipy)_3]^{-3} +[Co^*(bipy)_3]^{+2}$

(III) $[Co(NH_3)F]^{+2} + [CrH_2O)_6]^{+2} \rightarrow [Co(NH_3)_5(H_2O)]^{+2} + [Cr(H_2O)_5F]^{+2}$

(A) Marcus equation is applicable to I and II.

(B) Marcus equation is applicable to II only.

(C) Equation I and II involve inner sphere electron transfer.

(D) Equation I and III involve inner sphere electron transfer.

The correct statements are:

(a) A and B (b) B and C (c) B and D (d) C and D

132. The allowed electronic transition in fluorine molecule is

(a) $\sum_g^+ \rightarrow \sum_g^+$ (b) $\sum_g^+ \rightarrow \sum_g^+$ (c) $\sum_g^+ \rightarrow \pi_u$ (d) $\sum_g^+ \rightarrow \Delta_u$

CSIR DEC 2018

133. Consider the species NO , I_2 , I_2^- , Cu^{+2} and VO^{+2} . The number of paramagnetic species among them and the EPR inactive species, respectively, are

(a) 4 and I_2^- (b) 4 and I_2

(c) 3 and VO^{+2}, Cu^{+2} (d) 3 and NO, Cu^{+2}

134. The intermediate $[Fe(SCN)(H_2O)_5]^{+2}$ is detected in the reaction of $[Co(NCS)(NH_3)_5]^{+2}$ with $[Fe(H_2O)_6]^{+2}$ in aqueous medium to produce $[Co(H_2O)_6]^{+2}$ and $[Fe(H_2O)_6]^{+3}$

The mechanism of the reaction is

(a)Interchange dissociative (b) Interchange associative

(c) Inner sphere electron transfer (d) Outer sphere electron transfer

135. For magnesium complex of $EDTA^{2-}$, the number of N-donor and O-donor centers, are respectively.

(a) two and four (b) two and two (c) two and six (d) two and eight

136. The correct set of electronic configurations for metal ions in octahedral coordination geometry for strong Jahn-Teller distortion is

(a) $t^6_{2g}\, e^1_g$, $t^3_{2g}\, e^1_g$, $t^6_{2g}\, e^3_g$ (b) t^1_{2g}, $t^3_{2g}\, e^2_g$, $t^6_{2g}\, e^1_g$

(c) t^3_{2g} , $t^3_{2g}\, e^1_g$, $t^3_{2g}\, e^2_g$ (d) $t^3_{2g}\, e^2_g$, $t^6_{2g}\, e^2_g$, $t^6_{2g}\, e^3_g$

137. The correct order of intensity of the d-d transitions in the complexes of a 3d-transition metal ion

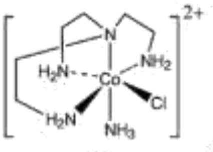
(a) cis-$[M(H_2O)_4Cl_2]$ > trans-$[M(H_2O)_4Cl_2]$ > $[M(H_2O)_6]^{+2}$

(b) $[M(H_2O)_6]^{+2}$> cis-$[M(H_2O)_4 Cl_2]$ > trans-$[M(H_2O)_4Cl_2]$

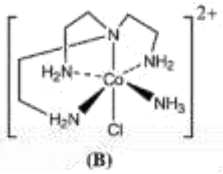
(c) trans-$[M(H_2O)_4Cl_2]$ > cis-$[M(H_2O)_4Cl_2]$ > $[M(H_2O)_6]^{+2}$

(d) $[M(H_2O)_6]^{+2}$> cis-$[M(H_2O)_4Cl_2]$ > trans-$[M(H_2O)_4Cl_2]$

138. The isomers A and B undergo base hydrolysis by forming a trigonal bipyramidal Intermediate. The correct statement is



(A)



(B)

(a) A reacts faster than B and both results in a mixture of products

(b) B reacts faster than A and both results in a mixture of products

(c) A reacts faster than B and B results in a mixture of products

(d) B reacts faster than A and A results in a mixture of products.

139. Consider the two sets of molecules.

Set A: $[AlF_6]^{-3}$, $[PF_6]^-$, $[SF_6]$ and $[SiF_6]^{-2}$ Set B: $[Ba(H_2O)_6]^{+2}$, $[Ca(H_2O)_6]^{+2}$, $[Mg(H_2O)_6]^{+2}$, $[Sr(H_2O)_6]^{+2}$ The slowest ligand exchange rate in Set A and Set B are, respectively

(a) $[AlF_6]^{-3}$ and $[Sr(H_2O)_6]^{+2}$ (c) $[SiF_6]^{-2}$ and $[Ca(H_2O)_6]^{+2}$

(b) $[SF_6]$ and $[Mg(H_2O)_6]^{+2}$ (d) $[PF_6]^-$ and $[Ca(H_2O)_6]^{+2}$

CSIR JUNE 2019

140. Self-exchange electron transfer is fastest in

(a) $[Ru(NH_3)_6]^{+2/+3}$ (b) $[Co(NH_3)_6]^{+2/+3}$

(c) $[Cr(OH)_6]^{+2/+3}$ (d) $[Fe(OH_2)_6]^{+2/+3}$

141. Consider the following reaction:

Hg^{+2} (aq) + X^- (aq) = $[HgX]^+$ (aq)

The stability constants for $[HgX]^+$ (aq) for X = F, Cl and Br follow the order

(a) F<Cl< Br (b) Br<Cl< F

(c) Cl< Br< F (d) Br< F<Cl

142. The correct set of information is

(a) $[Mn(H_2O)_6]^{+2}$: $\mu_{observed} = \mu_{spin}$;$[Co(H_2O)_6]^{+3}$: Paramagnetic

(b) $[Mn(H_2O)_6]^{+2}$: $\mu_{observed} > \mu_{spin}$;$[Co(H_2O)_6]^{+3}$: Diamagnetic

(c) $[Mn(H_2O)_6]^{+2}$: $\mu_{observed} = \mu_{spin}$;$[Co(H_2O)_6]^{+3}$: Diamagnetic

(d) $[Mn(H_2O)_6]^{+2}$: $\mu_{observed} > \mu_{spin}$;$[Co(H_2O)_6]^{+3}$: Paramagnetic

143. Consider the following statements regarding electronic spectra of high spin complexes

(A) Ti^{+3} complexes exhibit one sharp band.

(B) Co^{+2} and Cr+3 complexes exhibit two broad bands.

(C) Mn^{+2} complexes exhibit a series of very weak and sharp bands.

(D) Ni^{+2} complexes exhibit three broad bands .

The correct statements are

(a) A and C (b) A, C and D (c) C and D (d) B, C and D

144. Hydrolysis of trans-$[CoLCl(en)_2]^+$ (L= NO_2^-, NCS^-, OH^- ,Cl^-) results in a product (A). The tendency to form cis-isomer of the product (A) follows the order

(a) L= NO_2^-< NCS^-< OH^-<Cl^- (b) L= NO_2^-<Cl^-< NCS^-< OH^-

(d) L= OH^-< NCS^-<Cl^-< $NO2^-$ (c) L= OH^-<Cl^-< NO_2^-< NCS^-

145. Donor mode of NO ligand depends on the metal. Now, consider the following complexes (in gaseous state).

(A) $[IrCl(CO)(PPh_3)_2(NO)]^+$

(B) $[RuCl(PPh_3)_2(NO)_2]+$

(C) $[Co(NCS)(diars)_2(NO)]^+$, where diars →o-$(Me_2As)_2C_6H_4$.

(D) $[Cr(CN)_5(NO)]^{3-}$

The complex (es) that do NOT exhibit bent NO coordination mode is/are

(a) A and B (b) C and D (c) D only (d) B only

146. An aqueous solution of metal ion (A) gives a blood-red colored product (B) upon reaction with KSCN. Upon dropwise addition of NaF, the complex turns to a colorless compound (C). Identify A,B and C

(a) aq. Fe(II), $[Fe(SCN)(H_2O)_5]^+$ and $[Fe(H_2O)_6]^{+2}$

(b) aq. Fe(III), $[Fe(SCN)(H_2O)_5]^{+2}$ and $[FeF_6\ ]^{+3}$

(c) aq. Fe(II), $[Fe(SCN)(H_2O)_5]^+$and FeF_3

(d) aq. Fe(III), $[Fe(SCN)_3(H_2O)_3]^+$ and FeF_3

147. Correct order of molar extinction coefficient values of the visible absorption bands for the following species is

(a)$[Cr(H_2O)_6]^{+2}$> $[Mn(H_2O)_6]^{+2}$ >Chlorophyll >$[NiCl_4]^{-2}$

(b)Chlorophyll > $[NiCl_4]^{-2}$ > $[Cr(H_2O)_6]^{+2}$> $[Mn(H_2O)_6]^{+2}$

(c)$[NiCl_4]^{-2}$> Chlorophyll > $[Cr(H_2O)_6\ ]^{+2}$> $[Mn(H_2O)_6]^{+2}$

(d)Chlorophyll > $[Cr(H_2O)_6]^{+2}$ > $[NiCl]^{-2}$>$[Mn(H_2O)_6]^{+2}$

148. The correct statement about base hydrolysis of $[Co(py)_4Cl_2]^+$(py-pyridine) is

(a) rate expression is, Rate-k$[Co(py)_4Cl_2]^+$ $[OH^-]$

(b) reaction does not depend on hydroxide ion concentration

(c)reaction proceeds through $S_{N1}CB$ mechanism

(d)intermediate involved in this reaction is $[Co(py)_4Cl_2(OH)]$

149. $FeCr_2O_4$ and $NiGa_2O_4$ have normal and inverse spinel structures, respectively. The correct statement is

(a) Fe(II) and Ni(II) occupy octahedral sites

(b) Fe (II) and Ni(II) occupy tetrahedral and octahedral sites, respectively

(c) Cr(III) and Ga(III) occupy only octahedral sites

(d) Cr(III) and Ga(III) occupy tetrahedral and octahedral sites, respectively

150. The correct match of spin-only magnetic moment for the complexes cis-$[Fe(phen)_2\ (NCS\text{-}N)_2]$ (A) and $[Fe(phen)_3]Cl_2$ (B) at 300 K is (phen=1,10-phenantholine)

(a) 4.89 BM for both A and B (b) 0 BM for both A and B

(c) 4.89 BM for A and 0 BM for B (d) 0 BM for A and 4:59 BM for B

151. In the electronic spectrum of $[IrBr_6]^{2-}$, the number of charge transfer band(s) and their origin are respectively

(a) Two ligand → metal ($\sigma \rightarrow t_{2g}$ and $\sigma \rightarrow a_{1g}^*$)

(b) One ligand → metal ($\sigma \rightarrow e_g$)

(c) Two ligand → metal ($\sigma \rightarrow t_{2g}$ and $\sigma \rightarrow e_g$)

(d)One ligand → metal ($\sigma \rightarrow t_{2g}$)

CSIR - 2020

152. For the given reaction

$[{}^*Co(L)n]^{+2} + [Co(L)n]^{+3} \rightarrow [{}^*Co(L)n]^{+3} + [Co(L)n]^{+2}$

the correct statement with respect to the rate of electron transfer process is

o-phen = o-phenanthroline ; *Co is labeled atom

(a) fast electron transfer; L= NH_3; n = 6

(b) slow electron transfer ; L = o-phen; n = 3

(c) very slow electron transfer ; L = NH3 ; n = 3

(d) very slow electron transfer: L = o-phen; n = 3

153. The number of geometrical isomers of the complex $[RhH(C\equiv CR)_2(PMe_3)_3]$ is

(a) 2 (b) 3 (c) 4 (d) 1

154. I_2 is violet in the solid as well as in gas phase. However in acetone or ethanol, it turns brown. Choose the correct statement(s) for this colour change:

(a) Dissociation of I_2 in atomic state

(b) Interaction of low-lying σ*-orbital of iodine with lone pair of O (solvent)

(c) Formation of a charge-transfer complex

(a) (a) only (b) (b) only (c) (a) and (b) only (d) (b) and (c) only

155. The pair of compounds in which both members show LMCT band in their electronic spectra is

(a) $[FeCl_4]^{-2}$ and $[Fe(bpy)_3]^{+2}$ (b) $[FeBr_4]^{-2}$ and $[TcO_4]^-$

(c) $[ReO_4]^-$ and $[Ru(bpy)]^{+2}$ (d) $[Fe(phen)_3]^{+2}$ and $[FeCl_4]^{-2}$

156. For the d^3 electron configuration, the ground state term symbol is

(a) ${}^4F_{1/2}$ (b) ${}^4F_{3/2}$ (c) ${}^4F_{7/2}$ (d) ${}^4F_{9/2}$

157. The products A and B for the given reaction

$[Co(NH_3)_5Cl]^{+2} + [Cr(OH_2)_6]^{+2} + 5H_3O^+ \rightarrow A+B$

are respectively,

(a) $[Co(OH_2)_5Cl]^+$, $[Cr(OH_2)_6]_{+3}$ (b) $[Co(NH_3)_5(OH_2)]^{+2}$, $[Cr(OH_2)_5Cl]^{+2}$

(c) $[Co(OH_2)_6]^{+2}$, $[Cr(OH_2)_5Cl]^{+2}$ (d) $[Co(NH_3)_5Cl]^+$, $[Cr(OH_2)_6]^{+3}$

158. The number of expected electronic transitions in $[Cr(en)_3]^{+3}$ and trans-$[Cr(en)_2F]^{+}$at 4 K is, respectively (en = ethylenediamine)

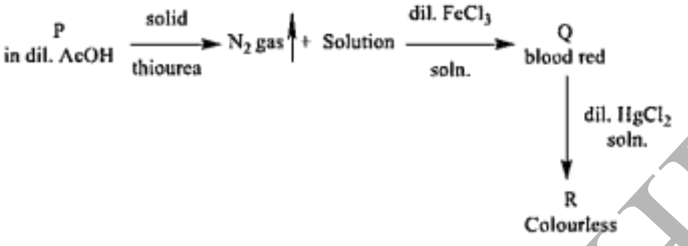
(a) 3 and 3 (b) 3 and 4 (c) 3 and 5 (d) 3 and 6

159. The value of magnetic moment will be independent of temperature for(acac = acetylacetonato; OAc = acetate; o-phen = o-phenathroline; Pz = pyrazolyl)

(a) $[Fe(acac)_3]$ (b) $[Cu(OAc)_4(H_2O)_2]$

(c) $[Fe(o\text{-}phen)_2(NCS)_2]$ (d) $[Fe\{(HC(3,5\text{-}Me_2Pz)_3\}_2]_{+2}$

160. In the following sequence of reactions the correct P, Q and R are respectively



(a) KNO_2 , CO_2 , $[Fe(H_2O)_5S]^+$, HgS

(b) KNO_2 , N_2, $[Fe(H_2O)_5(SCN)]^{2+}$, $[Hg(SCN)_4]^{2-}$

(c)KNO_3 , N_2, $[Fe(H_2O)_5(CN)]^{+2}$, $[Hg(OCN)_4]^{2-}$

(d) NaN_3, N_2 , $[Fe(H_2O)_5(N3)]^{+2}$, $[Hg(N_3)4]^{2-}$

161. The term symbol for the ground state of dinitrogen cation radical $(N_2)^+$ is

(a) ${}^2\pi_u$ (b) ${}^2\Sigma_u^-$ (c) ${}^2\pi_g$ (d) ${}^2\Sigma_g^+$

162. The calculated heat of formation (ΔH_f) for $NaCl_2$ and CaF is

(a) negative for both $NaCl_2$ and CaF (b) negative for $NaCl_2$ but positive for CaF

(c) positive for $NaCl_2$ but negative for CaF (d) positive for both $NaCl_2$ and CaF

CSIR JUNE 2021

163. Which of the following statements regarding dissociative substitution in an octahedral transition metal complex,

(1) High steric hindrance between ligands in the metal complex favours fast dissociation of ligand.

(2) Increased charge on the metal atom/ion of the complex favours the acceptance of electron pair of the entering ligands.

(3) A penta-coordinated intermediate is observed.

(4) Nature of the entering ligand significantly influences the reaction.

Which are correct?

(a) 1 and 4 (b) 1 and 3 (c) 1, 3 and 4 (d) 1, 2, 3 and 4

164. Consider an octahedral complex Ma2b2cd, where a, b, c, and d are monodentate ligands. The number of enantiomeric pairs for the complex is

(a) one (b) two (c) three (d) four

165. For the ligand-to-metal charge-transfer (LMCT) transitions in the oxo-anions given below, the wavelength of the transitions are in the order

(a) $VO_4^{3-} < CrO_4^{2-} < MnO_4^{-}$ and $WO_4^{2-} < MoO_4^{2-} < CrO_4^{2-}$

(b) $VO_4^{3-} < CrO_4^{2-} < MnO_4^{-}$ and $WO_4^{2-} > MoO_4^{2-} > CrO_4^{2-}$

(c) $VO_4^{3-} > CrO_4^{2-} > MnO_4^{-}$ and $WO_4^{2-} < MoO_4^{2-} < CrO_4^{2-}$

(d) $VO_4^{3-} > CrO_4^{2-} > MnO_4^{-}$ and $WO_4^{2-} > MoO_4^{2-} > CrO_4^{2-}$

166. Consider the following statements for the self-exchange electron transfer reaction in $[Cr(H_2O)_6]^{2+/3+}$

A. σ* orbitals are only involved in electron transfer

B. It involves large inner-sphere reorganization energy

C. It involves no change in M–L bond lengths

D. Rate of self-exchange electron transfer is fast

The correct statements are

(a) A, B and D (b) A and B (c) A and C (d) B and D

167. The number of CO bands for isomers from sets (i) and (ii) in their IR spectra

Set (i): Trigonal bipyramidal isomers, axial-$Fe(CO)_4L$ (A) and equatorial-$Fe(CO)_4L$(B)

Set (ii): Octahedral isomers, fac-$Mo(CO)_3L_3$(C) and mer-$Mo(CO)_3L_3$ (D) are

(a) A, 4 and B, 3; C, 3 and D, 2 (b) A, 4 and B, 3; C, 2 and D, 3

(c) A, 3 and B, 4; C, 3 and D, 2 (d) A, 3 and B, 4; C, 2 and D, 3

168. The absorption spectrum of $[Cr(NH_3)_6]^{3+}$ in water shows two bands around 475 and 365 nm. The ground term and the spin-allowed transitions, respectively, are

(a) ^4F; $^4T_{1g}(F) \rightarrow {}^4T_{2g}$ and $^4T_{1g} \rightarrow {}^4A_{2g}$ (b) ^4F; $^4A_{2g} \rightarrow {}^4T_{2g}$ and $^4A_{2g} \rightarrow {}^4T_{1g}(F)$

(c) ^2G; $^2E_g \rightarrow {}^2T_{1g}$ and $^2E_g \rightarrow {}^2T_{1g}$ (d) ^2F; $^4A_{2g} \rightarrow {}^2T_{2g}$ and $^2A_{2g} \rightarrow {}^2T_{1g}(F)$

169. For trigonal bipyramidal coordination complex (ML5) the correct point group symmetry and the relative order of the energies of the 3d orbitals in that crystal field, respectively are

(a) D_{3h}; $d_{x2-y2} > d_{z2}, > d_{xy} > d_{xz}, d_{yz}$ (b) D_{3d}; $d_z2, > d_{xy}, d_{x2-y2} > d_{xz}, d_{yz}$

(c) D_{3d}; $d_{x2-y2} > d_{z2}, d_{xy} > d_{xz}, d_{yz}$ (d) D_{3h}; $d_{z2}, > d_{x2-y2}$, dxy> d_{xz}, d_{yz}

•••••••

ANSWER KEY

COORDINATION CHEMISTRY

1.	(c)	2.	(c)	3.	(b)	4.	(a)	5.	(d)	6.	(a)	7.	(d)
8.	(b)	9.	(b)	10.	(b)	11.	(b)	12.	(d)	13.	(c)	14.	(b)
15.	(b)	16.	(b)	17.	(b)	18.	(d)	19.	(c)	20.	(d)	21.	(c)
22.	(c)	23.	(c)	24.	(b)	25.	(c)	26.	(c)	27.	(a)	28.	(c)
29.	(b)	30.	(a)	31.	(c)	32.	(d)	33.	(a)	34.	(a)	35.	(a)
36.	(b)	37.	(a)	38.	(a)	39.	(b)	40.	(c)	41.	(c)	42.	(a)
43.	(b)	44.	(d)	45.	(a)	46.	(b)	47.	(a)	48.	(a)	49.	(d)
50.	(c)	51.	(d)	52.	(b)	53.	(c)	54.	(a)	55.	(a)	56.	(a)
57.	(a)	58.	(a)	59.	(d)	60.	(a)	61.	(a)	62.	(a)	63.	(c)
64.	(a)	65.	(d)	66.	(a)	67.	(c)	68.	(a)	69.	(a)	70.	(c)
71.	(a)	72.	(a)	73.	(a)	74.	(a)	75.	(b)	76.	(d)	77.	(a)
78.	(c)	79.	(a)	80.	(a)	81.	(a)	82.	(c)	83.	(a)	84.	(a)
85.	(a)	86.	(c)	87.	(a)	88.	(a)	89.	(c)	90.	(b)	91.	(b)
92.	(b)	93.	(d)	94.	(b)	95.	(b)	96.	(b)	97.	(d)	98.	(c)
99.	(c)	100.	(d)	101.	(a)	102.	(a)	103.	(a)	104.	(d)	105.	(a)
106.	(c)	107.	(c)	108.	(b)	109.	(b)	110.	(b)	111.	(a)	112.	(a)
113.	(a)	114.	(a)	115.	(a)	116.	(b)	117.	(a)	118.	(a)	119.	(d)
120.	(a)	121.	(a)	122.	(a)	123.	(b)	124.	(b)	125.	(c)	126.	(c)
127.	(b)	128.	(c)	129.	(c)	130.	(c)	131.	(d)	132.	(c)	133.	(b)
134.	(c)	135.	(b)	136.	(a)	137.	(a)	138.	(c)	139.	(b)	140.	(a)
141.	(a)	142.	(a)	143.	(c)	144.	(c)	145.	(c)	146.	(b)	147.	(b)
148.	(b)	149.	(b)	150.	(c)	151.	(c)	152.	(c)	153.	(b)	154.	(d)
155.	(b)	156.	(b)	157.	(c)	158.	(d)	159.	(a)	160.	(b)	161.	(d)
162.	(c)	163.	(b)	164.	(b)	165.	(a)	166.	(b)	167.	(d)	168.	(b)
169.	(d)												

2

Organometallic Compounds

CSIR JUNE 2011

1. The oxidative addition and reductive elimination steps are favoured by
   (a) Electron rich metal centres.
   (b) Electron deficient metal centers
   (c) Electron deficient and electron rich metal centers respectively.
   (d) Electron rich and electron deficient metal centers respectively
2. Identify the order according to increasing stability of the following organometallic $TiMe_4$, $Ti(CH_2Ph)_4$, $Ti(i\text{-}Pr)_4$, and $TiEt_4$ (Me = methyl, Ph = phenyl, i-Pr = isopropyl, Et = ethyl)
   (a) $Ti(CH_2Ph)_4 < Ti(i\text{-}pr)_4 < TiEt_4 < TiMe_4$ (b) $TiEt_4 < TiMe_4 < Ti(i\text{-}Pr)_4 < Ti(CH_2Ph)_4$
   (c) $Ti(i\text{-}Pr)_4 < TiEt_4 < TiMe_4 < Ti(CH_2Ph)_4$ (d) $TiMe_4 < TiEt_4 < Ti(i\text{-}Pr)_4 < Ti(CH_2Ph)_4$
3. Oxidation occurs very easily in case of
   (a) $(\eta^5\text{-}C_5H_5)_2Fe$ (b) $(\eta^5\text{-}C_5H_5)_2$, Co (c) $(\eta^5\text{-}C_5H_5)_2$, Ru (d) $(\eta^5\text{-}C_5H_5)_2,Co^+$
4. Complex in which organic ligand is having only σ-bond with metal is:
   (a) $W(CH_3)_6$ (b) $(\eta^5\text{-}C_5H_5)_2$ Fe (c) $K[PtCl_3(C_2H_2)]$ (d) $(\eta^6\text{-}C_6H_6)_2$ Ru
5. Among the metals Mn, Fe, Co and Ni, the ones those would react in its native form directly with CO giving metal carbonyl compounds are:
   (a) Co and Mn (b) Mn and Fe (c) Fe and Ni (d) Ni and Co
6. In the $H_2Ru_6(CO)_{18}$ cluster, containing 8-coordinated Ru centers, the hydrogen atoms are
   (a) Both terminal (b) One terminal and the other bridging
   (c) Both bridging between two Ru centers (d) Both bridging between three Ru centers.
7. In the hydroformylation reaction, the intermediate $CH_3CH_2CH_2Co(Co)_4$:
   (a) Forms are acyl intermediate $CH_3CH_2CH_2COCo(CO)_3$
   (b) Forms an adduct with an olefin reactant.
   (c) Reacts with H_2
   (d) Eliminates propane.
8. In Ziegler-Natta catalysis the commonly used catalyst system is:
   (a) $TiCl_4$, $Al(C_2H_5)_3$ (b) $(\eta^5\text{-}Cp)_2TiCl_2$, $Al(OEt)_3$

(c) VO(acac)$_2$, Al$_2$(CH$_3$)$_6$ (d) TiCl$_4$, BF$_3$

CSIR DEC 2011

9. The correct combination of metal, number of carbonyl ligands and the charge for a metal carbonyl complex [M(CO)x]z- that satisfies the 18 electron rule is

(a) M= Ti, x=6, z =1
(b) M= V,x=6, z =1
(c) M=Co, x=4, z = 2
(d) M= Mo, x=5, z = 1

10. The stable cyclopentadienyl complex of beryllium is

(a) [Be(η^2-C$_5$H$_5$)$_2$]
(b) [Be(η^2-C$_5$H$_5$) (η^3-C$_5$H$_5$)]
(c) [Be(η^1-C$_5$H$_5$) (η^3-C$_5$H$_5$)]
(d) [Be(η^1-C$_5$H$_5$) (η^5-C$_5$H$_5$)]

11. Reaction of Fe(CO)$_5$ with OH leads to complex A which on oxidation with MnO$_2$ gives B. Compounds A and B respectively are

(a) [HFe(CO)$_4$]$^-$ and Fe$_3$(CO)$_{12}$
(b) [Fe(CO)$_5$(OH)]$^-$ and Fe$_2$(CO)$_{10}$
(c) [Fe(CO)$_4$]$^{-2}$ and Mn$_2$(CO)$_{10}$
(d) [HFe(CO)$_4$]$^-$, and Fe$_2$O$_3$

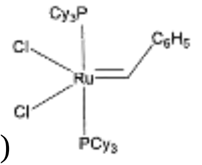
12. The number of metal-metal bonds in the dimers, [CpFe(CO)(NO)]$_2$ and [CpMo(CO)$_3$]$_2$ respectively, are

(a) two and two
(b) two and three
(c) one and two
(d) zero and one

13. In the trans-PtCl$_2$L(CO) complex, the CO stretching frequency for L= NH$_3$, pyridine, NMe$_3$ decreases in the order.

(a) pyridine > NH$_3$ > NMe$_3$
(b) NH$_3$ > pyridine > NMe$_3$
(c) NMe$_3$ > NH$_3$ > pyridine
(d) pyridine > NMe$_3$ > NH$_3$

14. The catalyst involved in carrying out the metathesis of 1-butene to give ethylene and 3-hexene is:

(a) 

(b) Na$_2$PdCl$_4$
(c) Co$_2$(CO)$_2$,H$_2$
(d) RhCl(PPh$_3$)$_2$

15. The greater stability of ((CH$_3$)$_3$ C-CH$_2^-$)$_4$ Ti(A) compared to that of ((CH$_3$)$_2$CH-CH$_2^-$)$_4$ Ti(B)is due to

(a) Hyperconjugation present in complex (A)

(b) β-hydride elimination is not possible in complex (A)

(c) Steric protection of titanium from reactive species in complex (A)

(d)The stronger nature of Ti-C bond in complex (A).

16. A compound A having the composition FeC9H8O3 shows one signal at 2.5 ppm and another one around 5.0 ppm in its 1H NMR spectrum. The IR spectrum of this compound shows two bands around 1680 cm^{-1}. The compound follows the 18 electron rule of the following statements for A, the correct one is/are

(A) It has η^5-C$_p$ group.
(B) It has a terminal CO ligand.
(C) It has a CH$_3$ ligand
(D) It has Fe-H bond.

(a) (A) and (B) only
(b) (C) only
(c) (A) and (C) only
(d) (B) and (D) only

CSIR JUNE 2012

17. The reactions of $Ni(CO)_4$ with the ligand (L= PMe_3 or $P(OMe)_3$) L yields $Ni(CO)_3L$. The reaction is

(a) Associative (b) Dissociative

(c) Interchange (I_a) (d) Interchange (I_d)

18. Among the following the strongest oxidizing agent is:

(a) $[WO_4]^{-2}$ (b) $[CrO_4]^{-2}$ (c) $[MoO_4]^{-2}$ (d)$[ReO_4]^{-2}$

19. For the reaction, trans-$[IrCl(CO)(PPh_3)_2] + Cl_2 \rightarrow$ trans - $[IrCl_3(CO)(PPh_3)_2]$ the correct observation

(a) $\bar{\upsilon}$ co (product) > $\bar{\upsilon}$ co (reactant) (b) $\bar{\upsilon}$ co (product)< $\bar{\upsilon}$ co (reactant)

(c) $\bar{\upsilon}$ co (product) = $\bar{\upsilon}$ co (reactant) (d) $\bar{\upsilon}$ co (product) = $\bar{\upsilon}$ co (free CO)

20. The carbonyl resonance in ^{13}C NMR spectrum of $[(\eta^5\text{-}C_5H_5)]Rh(CO)]_3$ (10^3Rh, nuclear spin, I = 1/2, 100 %) shows a triplet at -65° C owing to the presence of

(a) Terminal CO (b) μ_2-CO (c) μ_2-CO (d) $\eta^5\text{-}C_5H_5$

21. The cluster having arachno type structure is:

(a) $[Os_5(CO)_{16}]$ (b) $[Os_3(CO)_{12}]$ (c) $[Ir_4(CO)_{12}]$ (d) $[Rh_6(CO)_{16}]$

22. The final product of the reaction [Mn(CO)6]+ +MeLi → is:

(a) $[Mn\ (CO)_6]^+\ Me^-$

(b) $[Mn(CO)_5Me]$

(c) $[Mn(CO)_6]$

(d) $[(MeCO)Mn(CO)_5]$

23. The reaction $3[Rh_4(CO)_{12}] \rightarrow 2[Rh_6(CO)_{16}] + 4CO$ [25°C, 500 atm CO] is:

(a) Exothermic as more metal-metal bonds are formed.

(b) Endothermic as stronger metal-carbonyl bonds are cleaved while weaker metal-metal bonds are formed.

(c) Is entropicallyfavorable but enthalpicallyunfavorable such that ($\Delta G = 0$)

(d) Thermodynamically unfavourable ($\Delta G > 0$).

24. The complex that DOES NOT obey 18- electron rule is:

(a) $[(\eta^5 - C_5H_5)RuCl(CO)(PPh_3)]$ (b) $[W(CO)_3(SiMe_3)(Cl)(NCMe)_2]$

(c) $[IrCl_3(PPh_3)_2(AsPh)_2]^-$ (d) $[Os(N)Br_2(PMe_3)(NMe_2)]^-$

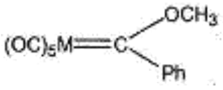
CSIR DEC 2012

25. The substitution of η^5-Cp group with nitric oxide is the easiest for

(a) $(\eta^5\text{-}Cp_2)Fe$ (b) $(\eta^5\text{-}Cp_2)CoCl$

(c) $(\eta^5\text{-}Cp_2)Ni$ (d) $(\eta^5\text{-}Cp_2)Co$

26. The molecule


$(OC)_5M{=}C(OCH_3)Ph$

Follow 18 electron rule. The two 'M' satisfying the condition are

(a) Cr, Re^+ (b) Mo, V (c) V, Re^+ (d) Cr, V

27. Complexes of general formula, fac-$[Mo(CO)_3(phosphite)_3]$ have the C-O stretching bands given below.

Phosphines: PF_3(A) ; PCl_3 (B); $P(Cl)Ph_2$ (C); PMe_3 (D)

$\bar{\upsilon}$ (CO), cm^{-1}: 2090 (i) ; 2040 (i); 1977 (iii); 1945 (iv)

The correct combination of the phosphine and the stretching frequency is,

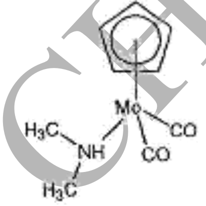
(a) (A-i), (B-ii), (C-iii), (D-iv) (b) (A-ii), (B-i), (C-iv), (D-iii)

(c) (A-iv), (B-iii), (C-ii), (D-i) (d) (A-iii), (B-iv), (C-i), (D-ii)

28. In the cluster $[Co_3(CH)(CO)_9]$ obeying 18e rule, the number of metal-metal bonds and the bridging ligands respectively, are

(a) 3 and 1 CH (b) 0 and 3 CO (c) 3 and 1 CO (d) 6 and 1 CH

29 For the following molecule:



Consider the following statements about its room temperature spectral data.

(A) 1H NMR has singlets at 5.48 and 3.18 ppm

(B) 1H NMR has multiplet at 5.48 and singlet at 3.18 ppm

(C) IR has CO stretching bands at 1950 and 1860 cm^{-1}

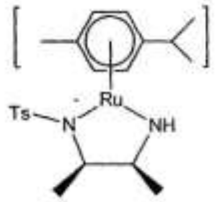
(D) IR has only one CO stretching band at 1900 cm^{-1}

The correct pair of statement is,

(a) A and C (b) B and C (c) A and D (d) B and D

30. Consider the catalyst in column-I and reaction in column-II

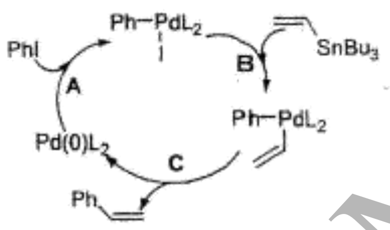
	Column-I		Column-II
A	[(R)-BINAP] Ru^{-2}	i.	Hydroformylation
B	$[Rh(CO)_2I_2]^{-1}$	ii.	asymmetric hydrogenation
C	$[Pd(PPh_3)_4]$	iii.	Asymmetric hydrogen transfer

D		iv.	Heck coupling

The best match of a catalyst of column-I with the reaction nuclear column-II is

(a) (A-ii), (B-i), (C-iv), (D-iii)
(b) (A-i), (B-ii), (C-iii), (D-iv)
(c) (A-iii), (B-i), (C-iv), (D-ii)
(d) (A-iv), (B-iii), (C-ii), (D-i)

31. Consider the following reaction mechanism



The steps A, B and C, respectively, are

(a) Oxidative addition; transmetallation; reductive elimination.

(b) Oxidative addition; carbopalladadation; β-hydride elimination.

(c) Carbopalladadation; transmetallation; reductive elimination.

(d) Metal halogen exchange; transmetallation; metal extrusion.

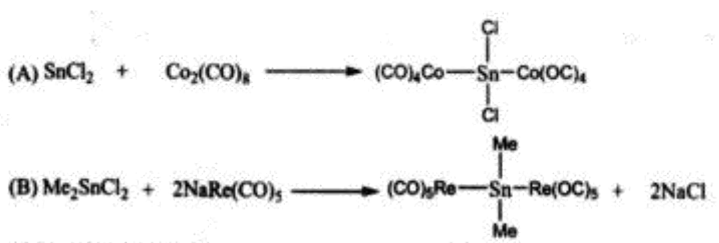
32. Which one of the following will NOT undergo oxidative addition by methyl iodide?

(a) $[Rh(CO)_2I_2]^-$
(b) $[Ir(PPh_3)_2(CO)Cl]$
(c) $[(\eta^2\text{-}CpRu(CO)_2]$
(d) $[(\eta^5\text{-}Cp_2Ti(Me)Cl]$

33. In hydrofomylation reaction using $[Rh(PPh_3)_2(CO)(H)]$ as the catalyst, addition of excess PPh_3, would

(a) increase the rate of reaction
(b) decrease the rate of reaction.
(c) not influence of the rate of reaction
(d) stop the reaction.

34. Reactions A and B are, termed as respectively.


(A) SnCl₂ + Co₂(CO)₈ → (CO)₄Co—Sn—Co(OC)₄
Cl
Cl
(B) Me₂SnCl₂ + 2NaRe(CO)₅ → (CO)₅Re—Sn—Re(OC)₅ + 2NaCl
Me
Me

(a) Insertion, Metathesis
(b) Metathesis, insertion
(c) Oxidative, addition, metathesis
(d) Oxidative addition, insertion

35 In the metal-olefin interaction, the extent of increase in metal olefin -back-donation would

(a) lead to a decrease in C=C bond length

(b) change the formal oxidation state of the metal

(c) change the hybridisation of the olefin carbon from sp^2 to sp^3.

(d) increase with the presence of electron donating substituent on the olefin.

CSIR JUNE 2013

36. The oxidation state of molybdenum in $[(\eta^7\text{-tropylium})Mo(CO)_3]^+$ is:

(a) +2 (b) +1 (c) 0 (d) -1

37. The reaction, $[(CO)_5 Mn (Me)] + CO \rightarrow [(CO)_5 Mn \{C(O)Me\}]$is an example for

(a) oxidative addition (b) electrophilic substitution

(c) nucleophilic substitution (d) migratory insertion

38. The orders of reactivity of ligands, NMe3 PMe3, and CO with complexes MeTiCl, and $(CO)_5Mo$ (thf) are

(a) CO > PMe_3 > NMe_3 and CO > NMe_3 > PMe_3

(b) PMe_3 > CO > NMe_3 and NMe_3 > CO > PMe_3

(c) NMe_3 > PMe_3 > CO and CO > PMe_3 > NMe_3

(d) NMe_3 > CO> PMe_3 and PMe_3 > NMe_3 > CO

39. The number of metal-metal bonds in $[W2(OPh)_6]$ is:

(a) 1 (b) 2 (c) 3 (d) 4

40. The number of metal-metal bonds in $Ir_4(CO)_{12}$ is

(a) 4 (b) 6 (c) 10 (d) 12

CSIR DEC 2013

41. The bond order of the metal-metal bond in the dimeric complex $[Re_2Cl_4(PMe_2Ph)_4]$ is

(a) 4.0 (b) 3.5 (c) 3.0 (d) 2.5

42. Which of the following in NOT suitable as catalyst for hydroformylation?

(a) $HCo(CO)_4$ (b) $HCo(CO)_3PBu_3$

(c) $HRh(CO)(PPh_3)_3$ (d) $H_2Rh(PPh_3)_2Cl$

43. In a cluster, H_3CoRu_3(CO) 12 total number of electrons considered to be involved in its formation is

(a) 57 (b) 60 (c) 63 (d) 72

44. Among the following clusters,

A = $[(H)Co_6 (CO)_{15}]$ B = $[(H)_2Os_6 (CO)_{18}]$ C = $[(H)_2 Os_5(CO)_{16}]$

H is encapsulated in

(a) A only (b) B only (c) B and C only (d) A and B only

45. The correct statement regarding terminal/bridging CO groups in solid $Co_4(CO)_{12}$ and Ir_4(CO) 12 is

(a) both have equal number of bridging CO groups

(b) number of bridging CO groups in $Co_4(CO)_{12}$ is 4

(c) the number of terminal CO groups in $Co_4(CO)_{12}$ is 8

(d) the number of bridging CO groups in $Ir_4(CO)_{12}$ is zero.

46. The electrophile Ph_3C reacts with $[(\eta^5\text{-}C_5H_5)\,Fe(CO)_2(CDMe_2)]^+$ to give a product A. The product A is formed because

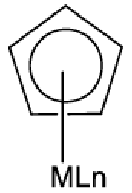
(a) Fe is oxidized
(b) alkyl is substituted with Ph_3C
(c) Fe-Ph bond is formed
(d) Alkyl is converted to alkene

47. Among the following, the correct statement is

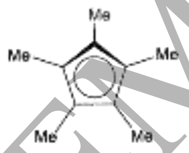
(a) CH is isolobal to $Co(CO_3)$
(b) CH_2 is isolobal to $Ni(CO)_2$
(c) CH is isolobal to $Fe(CO_4)$
(d) CH_2 is isolobal to $Mn(CO)_4$

48. Substitution of L with other ligands will be easiest for the species

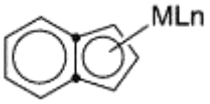
(a)



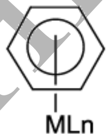
(b)



(c)

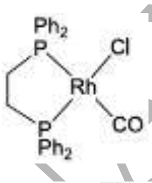


(d)

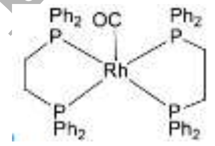


49. Reaction of $Ph_2PCH_2CH_2PPh_2$ with $[RhCl(CO)_2]_2$ in a 2:1 molar ratio gives a crystalline solid A. The IR spectrum of complex A shows vco at 1985 cm^{-1}. The^{31} P(1H) NMR spectrum of A consists of two doublets of doublets of equal intensities (^{103}Rh is 100% abundant and I =1/2). The structure of complex A is

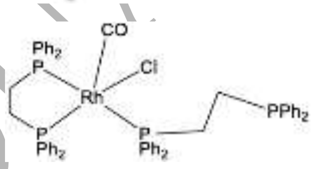
(a)



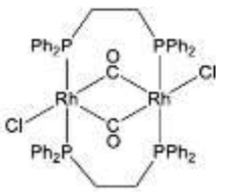
(b)



(c)



(d)



50. On reducing $Fe_3(CO)_{12}$ with an excess of sodium, a carbonylate ion is formed. The iron is isoelectronic with

(a) $[Mn(CO)_5]^-$
(b) $[Ni(CO)_4]$
(c) $[Mn(CO)_5]^+$
(d) $[V(CO)_6]^-$

CSIR JUNE 2014

51. The ligand(s) that is (are) fluxional in $[(\eta^5\text{-}C_5H_5)(\eta\text{-}C_5H_5)Fe(CO)_2]$ in the temperature range 221-298K, is (are)

(a) $\eta^5\text{-}C_5H_5$
(b) $\eta^1\text{-}C_5H_5$
(c) $\eta^5\text{-}C_5H_5$ and CO
(d) $\eta^1 C_5H_5$ and CO

52. The typical electronic configurations of the transition metal centre for oxidative addition

(a) d^0 and d^8
(b) d^6 and d^8
(c) d^8 and d^{10}
(d) d^5 and d^{10}

53. The oxidation state of Ni and the number of metal-metal bonds in $[Ni_2(CO)_6]^{2-}$ that are consistent with the 18 electron rule are

(a) Ni (-II), I bond
(b) Ni(IV), 2 bonds
(c) Ni(-I), 1 bond
(d) Ni(IV), 3 bonds

54. The compound $[Re_2(Me_2PPh)\ 2CI_4]$ (M) having a configuration of $\sigma^2\pi^4\delta^2\delta^{*2}$ can be oxidized to M^+ and M^{2+}. The formal metal-metal order in M, M^+ and M^{+2} respectively, are

(a) 3.0, 3.5 and 4.0
(b) 3.5, 4.0 and 3.0
(c) 4.0, 3.5 and 3.0
(d) 3.0, 4.0 and 3.5

$[Re_2(Me_2PPh)\ 2CI_4]$ = (M)

55. The total valence electron count and the structure type adopted by the complex $[Fe_3(CO)_{15}C)]$ respectively, are

(a) 74 and nido
(b) 60 and closo
(c) 84 and arachno
(d) 62 and nido

56. ^{1}H NMR spectrum of $[\eta^5\text{-}C_5H_5Rh)(C_2H_4)_2]$ at -20°C shows a typical AA' XX' pattern in the olefinic region. On increasing the temperature to -70°C, the separate lines collapse into a single line which is due to

(a) free rotation of the ethylene ligand about the metal-olefin bond
(b) interamolecular exchange between the ethylene ligands

(c) intermolecular exchange between the ethylene ligands
(d) change in hapticity of the cyclopentadienyl ligand

57. Amongst the following which is not isolobal pairs

(a) $Mn(CO)_5$, CH_3
(b) $Fe(CO)_4$, O
(c) $Co(CO)_3$, R_2Si
(d) $Mn(CO)_5$, RS

CSIR DEC 2014

58. The hepticities 'x' and 'y' of the arene moieties in the diamagnetic complex $[(\eta^x\text{-}C_6H_6)Ru(\eta^y\text{-}C_6H_6)]$ respectively are

(a) 6 and 6
(b) 4 and 4
(c) 4 and 6
(d) 6 and 2

59. The rate of the reaction $Ni(CO)_4 + PPh_3 \xrightarrow{\Delta} [Ni(CO)_3(PPh_3)] + CO$ depends on

(a) Concentration of both the reactants
(b) Concentration of $Ni(CO)_4$ only
(c) Concentration of PPh_3 only
(d) The steric bulk of PPh_3

60. The product of the reaction of propene, CO and H_2 in the presence of $Co_2(CO)_8$ as a catalyst is

(a) Butanoic acid (b) Butanal

(c) 2-butanone (d) Methylpropanoate

61. The point group symmetries for trans-$[Cr(en)_2F_2]^+$ and $[TiCl_6]^{-3}$, respectively, are

(a) D_{4d} and D_{3d} (b) D_{3d} and D_{4d} (c) D_{4h} and D_{3h} (d) D_{3h} and D_{4h}

62. $Co_4(CO)_{12}$ adopts the

(a) closo-structure (b) nido-structure (c) arachno-structure (d) hypho-structure

63. Reductive elimination step in hydrogenation of alkenes by Wilkinson catalyst results in (neglecting solvent in coordination sphere of Rh)

(a) T-shaped $[Rh(PPh_3)_2Cl]$ (b) Trigonal-planar $[Rh(PPh_3)_2Cl]^{2+}$

(c) T-shaped $[Rh(H)(PPh_3)Cl]^+$ (d) Trigonal-planar $[Rh(H)(PPh_3)_2]$

64. $NaI(\eta^5\text{-}C_5H_5)Fe(CO)_2]$ reacts with Br_2 to give A. Reaction of A with $LiAlH_4$ results in B. The proton NMR spectrum of B consists of two singlets of relative intensity 5 : 1. Compounds A and B respectively, are

(a) $(\eta^5\text{-}C_5H_5)Fe(CO)_2Br$, and $(\eta^5\text{-}C_5H_5)Fe(CO)_2H$

(b) $(\eta^4\text{-}C_5H_5)Fe(CO)_2Br_2$ and $(\eta^4\text{-}C_5H_5)Fe(CO)_2HBr$

(c)($\eta^5\text{-}C_5H_5)Fe(CO)_2Br$ and $(\eta^4\text{-}C_5H_5)Fe(CO)_2(H)_2$

(d) $(\eta^5\text{-}C_5H_5)Fe(CO)_2Br$ and $(\eta^5\text{-}C_5H_5)Fe(CO)_2HBr$

65. The compound that undergoes oxidative addition reaction in presence of H_2, is

(a) $[Mn(CO)_5]^{-1}$ (b) $[(\eta^5\text{-}C_5H_5)MCO_3]^{-1}$

(c) $[IrCl(CO)(PPh_3)_2]$ (d) $[(\eta^5\text{-}C_5H_5)_2ReH]$

66. ^1H NMR spectrum of free benzene shows a peak at –7.2 ppm. The expected chemical shift (in ppm) of C_6H_6 ligand in ^1H NMR spectrum of $[(\eta^6\text{-}C_6H_6)Cr(CO)_3]$ and the reason for it, if an, is/are

(a) 4.5; disruption of ring current

(b) 9.0; inductive effect

(c) 7.2

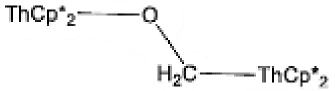
(d) 2.5 combination of inductive effect and disruption of ring current.

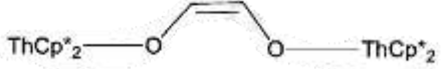
67. According to Wade's rule, anion $C_2B_9H_{12}$ adopts

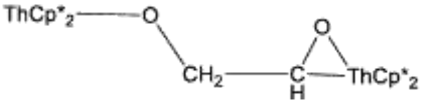
(a) closo-structure (b) nido-structure

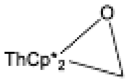
(c) arachno-sturcture (d) hypho-structure

68. The final product in the reaction of $[C_pThH]$ with CO in an equimolar ratio is

(a) 

(b) 

(c) 

(d) 

69. Complexes $HM(CO)_5$ and $[((\eta^5\text{-}C_5H_5)M'(CO)_3]_2$ obey the 18-electron rule. Identify M and M' and their ^1H NMR chemical shifts relative to TMS.

(a) M = Mn, -7.5; M'= Cr, 4.10
(b) M = Cr, -4.10; M'= Mn, -7.5
(c) M =V, -7.5; M'= Cr, 4.10
(d) M = Mn, -10.22 M'= Fe, 2.80

CSIR JUNE 2015

70. The binding modes of NO in 18 electron compounds [Co(CO)3(NO)] and [Ni(η5-Cp) (NO)], respectively, are

(a) linear and bent (b) bent and linear (c) linear and linear (d) bent and bent

71. The role of copper salt as co-catalyst in Wacker process is

(a) oxidation of Pd(0) by Cu(II)
(b)oxidation of Pd(0) by Cu(I)
(c) oxidation of Pd(II) by Cu(I)
(d) oxidation of Pd(II) by Cu(II)

72. For typical Fischer and Schrock carbenes, consider the following statements

A. Oxidation state of metal is low in Fischer carbene and high in Schrock carbene

B. Auxilliary ligands are π-acceptor in Fischer carbene and non π acceptor in Schrock carbene

C. Substituents on carbene carbon are non π donor in Fischer carbene and π donor in Schrock carbene

D. Carbene carbon is electrophilic in Fischer carbene and nucleophilic in Schrock carbene

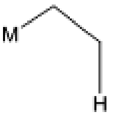
The correct statements are

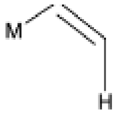
(a) A, B and C (b) A, B and D (c) B. C and D (d) A, C and D

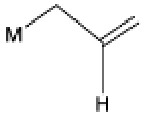
73. The refluxing of $RhCl_3.3H_2O$ with an excess of PPh_3, in ethanol gives a complex A. Complex A and the valence electron count on rhodium are, respectively.

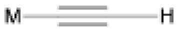
(a) $[RhCl(PPh_3)_3]$, 16
(b) $[RhCl(PPh_3)_5]$, 16
(c) $[RhCl(PPh_3)_3]$, 18
(d) $[RhCK(PPh_3)_5]$, 18

74. The β-hydrogen elimination will be facile in

(a) 

(b) 

(c) 

(d) 

75. The reaction $[Co(CN)_5H_2O]^{2-} + X^- \rightarrow [Co(CN)_5X]^{2-} + H_2O$ follows a/an

(a) Interchange dissociative (I_d) mechanism
(b) Dissociative (D) mechanism

(c) Associative (A) mechanism (d) Interchange Associative (I_a) mechanism

76. According to Wade's theory the anion $[B_{12}H_{12}]^{2-}$ adopts

(a) closo-structure (b) arachno-structure

(c) hypo-structure (d) nido-structure

77. The reaction of $SbCl_3$, with 3 equivalents of EtMgBr yields compound X. Two equivalents of SbI_3 react with one equivalent of X to give Y. In the solid state, Y has a 1D-polymeric structure in which each Sb is in a square pyramidal environment. Compounds X and Y respectively, are

(a) $SbEt_3$, and $[Sb(Et)I_2]_n$ (c) $SbEt_3$, and $[SbEt_2Br_2]_n$

(b) $Sb(Et_2)Cl$ and $[Sb(Et)Cl]_n$ (d) $Sb(Et)Br_2$ and $[SbEt(I)(Br)]_n$

78. The following statements are given regarding the agostic interaction C-H----Ir observed in $[Ir(Ph_3P)_3Cl]$.

(A) Upfield shift of C-H proton in 1H NMR spectrum

(B) Increased acid character of C-H

(C) $\bar{\upsilon}$ co- in IR spectrum shifts to higher wavenumber

The correct answer is/are:

(a) A and C (b) B and C (c) A and B (d) C only

79. Match column A (coupling reactions) with column B (reagents)

	Column-A		Column-B
(1)	Suzuki coupling	(I)	H_2C=CHCO CH
(2)	Heck coupling	(II)	RB(OH),
(3)	Sonagashira coupling	(III)	PhCO(CH) Znl
(4)	Negeshi coupling	(IV)	CHECR
		(V)	SnR

The correct match is:

(a) I-II, 2-1, 3-IV, 4-III (b) 1-1, 2-V. 3-III, 4-IV

(c) 1-IV, 2-III, 3-11, 4-1 (d) 1-11.2-111, 3-IV,4-V

80. Amongst the following

(A) $[Mn(\eta^5\text{-}Cp)(CO)_3]$ (B) $[Os\ (\eta^5\text{-}Cp)_2]$

(C) $[Ru\ (\eta^5\text{-}Cp)_2]$ and (D) $[Fe(\eta^5\text{-}Cp)_2]$

the compounds with most shielded and deshielded C_p protons respectively, are

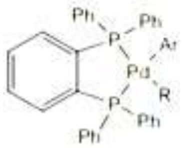
(a) D and A (b) D and B (c) C and A (d) C and B

81. Total number of vertices in metal clusters $[Ru_6(C)(CO)_{17}]$ $[Os_5(C)(CO)_{15}]$ and $[Ru_5(C)(CO)_{16}]$ are 6, 5 and 5, respectively. The predicted structures of these complexes, respectively are

(a) closo, nido and nido (b) closo, nido and arachno

(c) arachno, closo and nido (d) arachno, nido and closo

82. The reductive elimination of Ar-R (coupled product) from A is facile when

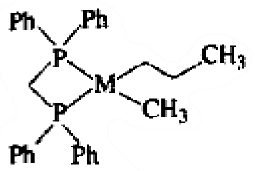
(a) 

(b) $R = CH_3$

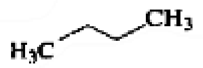
(c) $R = CH_2Ph$

(d) $R\ CH_2COPh$

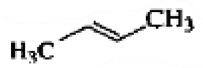
83. The least probable product from A on reductive elimination is

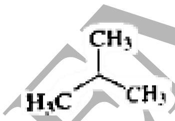


A

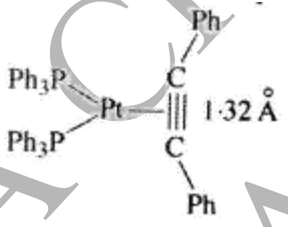
(a) 

(b) CH_4

(c) 

(d) 

84. With respect to and bonding in Pt III in the structure given below, which of the following represent the correct bonding diagram



(a) $M(\sigma) \rightarrow L(\sigma)$ and $M(\pi) \rightarrow L(\pi^*)$

(b) $L(\sigma) \rightarrow M(\pi)$ and $L(\pi) \rightarrow M(\pi)$

(c) $L(\pi) \rightarrow M(\pi)$ and $L(\sigma) \rightarrow M(\pi)$

(d) $L(\pi) \rightarrow M(\sigma)$ and $M(\pi) \rightarrow L(\pi^*)$

CSIR DEC 2015

85. The W-W bond order in $[W(\eta^5\text{-}C_5H_5)(\mu\text{-}Cl)(CO)_2]_2$ is

(a) three (b) two (c) one (d) zero

86. For the reaction of $[Fe(\eta^5\text{-}C_5H_5)(CH_3)(CO)_2]$ with PMe_3, the main intermediate is

(a) $[Fe(\eta^5\text{-}C_5H_5)(CH_3)(CO)_2\ (PMe_3)]$

(b) $[Fe(\eta^5\text{-}C_5H_5)(COCH_3)(CO)]$

(c) $[Fe(\eta^3\text{-}C_5H_5)(CH3)(CO)_2]$

(d)) $[Fe(\eta^3\text{-}C_5H_5)(COCH_3)(CO)(PMe_3)]$

87. $[(\eta^3\text{-}C_3H_5)Mn(CO)_4]$ shows fluxional behavior. The 'H NMR spectrum of this compound when it is in the non-fluxional state shows

(a) one signal

(b) two signals in the intensity ratio of 4 : 1

(c) three signals in the intensity ratio of 2 : 2 : 1

(d) five signals of equal intensity.

88. Using Wade's rules predict the structure type of [$C_2B_5H_7$]

(a) nido (b) closos (c) arachno (d) hypho

89. For uranocene, the correct statement(s) is/are

(A) oxidation state of uranium is ‘+4’ (B) it has cyclooctatetraenide ligands

(C) it is bent sandwich compound (D) it has ‘-2’ charge.

Correct answer is

(a) A and B (b) B and C (c) A and D (d) B only

90. The final products of the reaction of carbonyl metalates $[V(CO)_6]^-$ and $[Co(CO)_4]$– with H_3PO_4 respectively, are

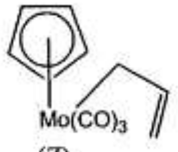
(a) $V(CO)_6$ and $HCo(CO)_4$ (b) $HV(CO)_6$ and $Co_2(CO)_8$

(c) $[H_2V(CO)_6]^+$ and $HCo(CO)_4$ (d) $V(CO)_6$and $Co_2(CO)_8$

91. The number of valence electrons provided by [$Ru(CO)_3$] fragment towards cluster bonding is

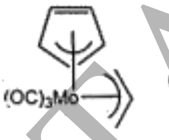
(a) 1 (b) 14 (c) 6 (d) 2

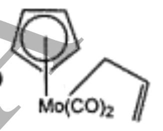
92. The intermediate and the final major product of photolysis of Z

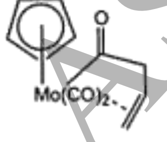


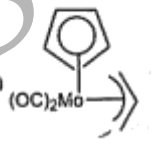
(Z)

From the following are

(A)


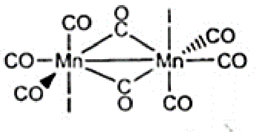
(B)


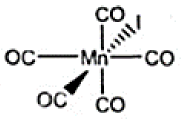
(C)


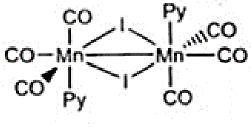
(D)


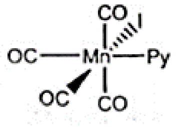
(a) A and D (b) B and D (c) B and C (d) A and C

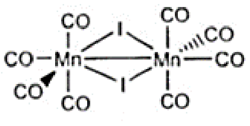
93. Reaction of [$Mn_2(CO)_{10}$], with I_2, results in A without loss of CO. Compound A, on heating of 120°C loses a CO ligand to give B, which does not have a Mn-Mn bond. Compound B reacts with pyridine to give 2 equivalents of C. Compounds A, B and C from the following respectively, are

(I)


(II)


(III)


(IV)


(V)


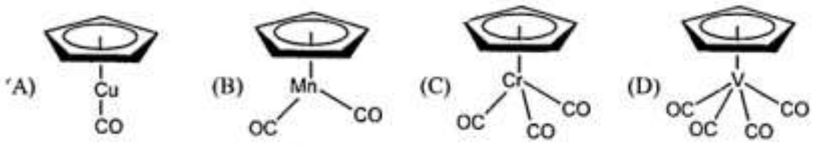
(a) II, V and IV (b) II, III and IV (c) V, III and IV (d) II. V and III

94. The approximate positions of ν_{co} bands (cm^{-1}) in the solid-state infrared spectrum and the Fe-Fe bond order in $[Fe(\eta^5\text{-}C_5H_5)(\mu\text{-}CO)(CO)]_2$ (non-centrosymmetric) respectively, are

(a) (2020, 1980, 1800) and one (b) (2020, 1980, 1800) and two

(c) (2020, 1980) and one (d) (2143) and one

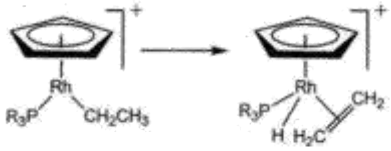
95. Identify the species, those obey the 18 electron rule, from the following:



(a) A and B (b) B and C

(c) C and D (d) A and D

96. The following transformation is an example of



(a) oxidative addition

(b) insertion

(c) β-hydride elimination.

(d) reductive elimination.

97. CpM [Cp is (η^5-C_5H_5)] fragment isolobal with a BH fragment is

(a) CpGe (b) CpMn (c) CpRu (d) CpCo

98. The number of metal-metal bonds in $[Co_2Fe_2(CO)_{11}(\eta^4\text{-PPh})_2]$ is

(a) 3 (b) 4 (c) 5 (d) 6

99. Choose the correct option for carbonyl fluoride with respect to bond angle and bond length

(a) ∠F-C-F >∠F-C-O and C-F > C-O (b) ∠F-C-F >∠F-C-O and C-F < C-O

(c) ∠F-C-F <∠F-C-O and C-F > C-O (d) ∠F-C-F <∠F-C-O and C-F < C-O

100. Correct order of M-C bond length of metallocenes (a-c)

1. $[Fe(\eta^5\text{-Cp})_2]$ 2. $[Ni(\eta^5\text{-Cp})_2]$ 3. $[Co(\eta^5\text{-Cp})_2]$ is

(a) A > B > C (b) B > C > A (c) C > B > A (d) A > C > B

101. The ^{1}H NMR spectrum of $[Ru(\eta^4\text{-}C_8H_8)(CO)_3]$ at 23°C consists of a sharp single line. The number of signals observed at low temperature (-140 °C) in its spectrum is

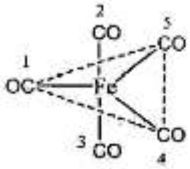
(a) 8 (b) 6 (c) 4 (d) 2

102. The numbers of skeletal electrons present in the compounds $C_2B_3H_5$, $C_2B_4H_6$, and B_5H_9 are, respectively

(a) 10, 12 and 12 (b) 12, 14 and 14

(c) 10, 12 and 14 (d) 12, 14 and 12

103. For fluxional $Fe(CO)_5$ (structure given below) in solution, the exchange of numbered CO groups will be between



(a) 2 and 5; 3 and 4 (b) 2 and 3; 4 and 5

(c) 2 and 3; 1 and 5 (d) 1 and 2; 4 and 5

104. In the following reaction sequence

$$HNEt_2 + CS_2 \xrightarrow{KOH} P \xrightarrow{aq.soln} R$$

$$I_2 \xrightarrow{[CpMo(CO)_3]^2} S$$

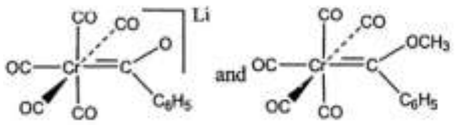
Where dtc = dithiocarbamate and tds = thiuramdisulfide.

Identify P, R and S. Cp= η5- C5H5

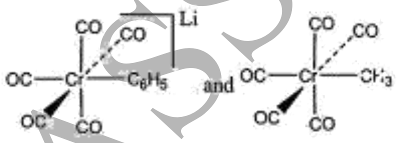
	P	R	S
(a)	$Et_2dtc^-K^+$	Et_4tds	$CpMo(Et_2dtc)(CO)_2$
(b)	$Etdtc^-K^+$	Et_3tds	$CpMo(Et_3dtc)(CO)_2$
(c)	$Et_4dtc^-K^+$	Et_2tds	$CpMo(Et_4dtc)(CO)$
(d)	$Etdtc^-K^+$	Ettdc	CpMo(Etdtc)(Co)

105. Reaction of $Cr(CO)_6$ with LiC_6H_5 gives A which reacts with [MeO][BF] to give B. The structures of A and B respectively, are

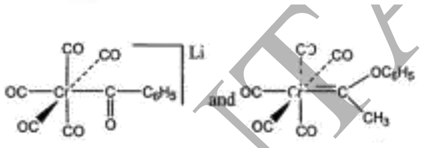
(a)



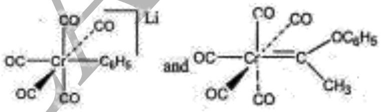
(b)



(c)



(d)

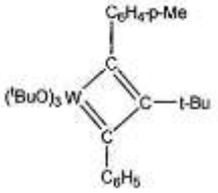


106. Heating a sample of $[(\eta^5\text{-}C_5H_5)Mo(CO)_3]_2$ results in the formation of $[(\eta^5\text{-}C_5H_5)Mo(CO)_2]$ with elimination of 2 equivalents of CO. The Mo-Mo bond order in this reaction changes from

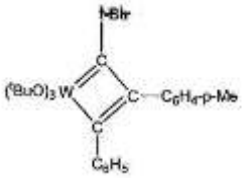
(a) 2 to 3 (b) 1 to 2 (c) 1 to 3 (d) 2 to 4

107. A plausible intermediate involved in the self metathesis reaction of $C_5H_5\text{-}C \equiv C\text{-}C_6H_4\text{-p Me}$ catalyzed by $[({}^tBuO)_3W \equiv C\text{-}{}^tBu]$ is

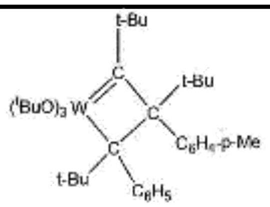
(a)



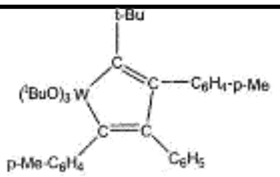
(b)



(c)



(d)



CSIR DEC 2016

108.The number of bridging ligand(s) and metal-metal bond(s) present in the complex $Ru_2(\eta^5$-$Cp)_2(CO)_2(Ph_2PCH_2PPh_2)]$ (obeys 18-electron rule), respectively, are

(a) 0 and 1 (b) 2 and 1 (c) 3 and 1 (d) 1 and 2

109. The rate of alkene coordination to $[PtCl_4]^{-2}$ is highest for

(a) norbornene (b) ethylene (c) cyclohexene (d) 1-butene

110. Consider the following statements, I and II:

I : $[Rh(CO)_2\ I_2]^-$ catalytically converts CH_3I and CO to CH_3COI

II : $[Rh(CO)_2I_2]^-$ is diamagnetic in nature

The correct from the following is

(a) I and II are correct and II is an explanation of I

(b) I and II are correct and II is not an explanation of I

(c) I is correct and II is incorrect

(d) I and II are incorrect

111. The geometry of $[ReH_9]^{-2}$ is

(a) monocapped square antiprism (b) monocapped cube

(c) tricapped trigonal prism (d) heptagonal bipyramid

112. According to isolobal analogy, the right set of fragments that might replace $Co(CO)_3$ in $[Co_4(CO)_{12}]$ is

(a) CH, BH and $Mn(CO)_5$ (b) $Fe(CO)_4$, CH_2 and $SiCH_3$

(c) P, CH and $Ni(\eta^5\text{-}C_5H_5)$ (d) BH, $SiCH_3$ and P

113. According to Wade's rules, the correct structural types of $[Co(\eta^5\text{-}C_5H_5)B_4H_8]$ and $[Mn(\eta^2\text{-}B_3H_8)(CO)_4]$ are

(a) closo and nido (b) nido and arachno

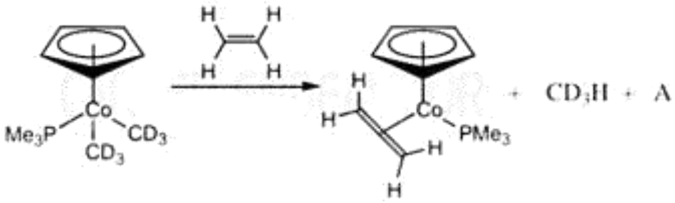
(c) closo and arachno (d) nido and nido

114. The correct geometry of $[Rh_6C(CO)_{15}]^{-2}$ is

(a) octahedron (b) pentagonal pyramid

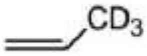
(c) trigonal prism (d) monocapped square pyramid

115. Product A in the following reaction is



(a) $D_2C = CD_2$ (b) $D_3C\text{-}CD_3$

(c)

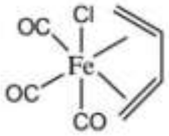


(d) $H_2C = CD_2$

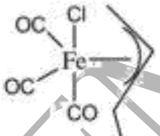
CSIR JUNE 2017

116. Treatment of Fe(CO)5 with 1, 3-butadiene gives B that shows two signals in its ^{1}H NMR spectrum. B on treatment with HCl yields C which shows four signals in its ^{1}H NMR spectrum. The compound C is

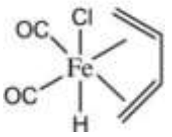
(a)



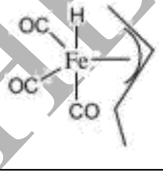
(b)



(c)



(d)



CSIR JUNE 2017

117. Choose the isoelectronic pair among the following:

A. $[V(CO)_6]$ B. $[Cu(\eta^5\text{- }C_5H_5)(CO)]$

C. $[Co(CO)_4]^-$ D. $[IrCl(CO)(PPh_3)]$

(a) A and B (b) B and C (c) C and D (d) A and D

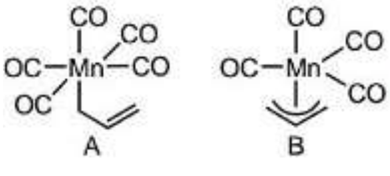
118. An organometallic fragment that is isolobal to CH_3^+ is

(a) $[Fe(CO)_5]$ (b) $[Mn(CO)_5]$

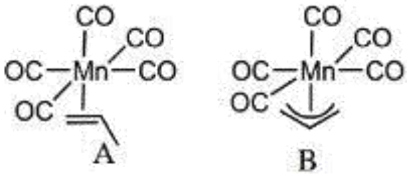
(c) $[Cr(CO)_5]$ (d) $[Ni(CO)_3]^+$

119. Reaction of $Na[Mn(CO)_5]$ with $H_3C = CHCH_2Cl$ gives A along with NaCl. Photolysis of compound A results in compound B together with elimination of CO. The correct structural formulations of compounds A and B are respectively,

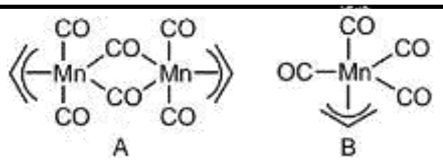
(a)



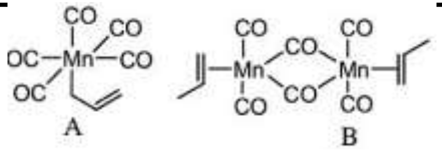
(b)



(c)



(d)



CSIR JUNE 2017

120. The number of bonding molecular orbitals and the number of available skeletal electrons in $[B_6H_6]^{-2}$, respectively, are:

(a) 7 and 14 (b) 6 and 12 (c) 18 and 12 (d) 11 and 14

121. Addition of $NaBH_4$ to $[(\eta^5\text{-}C_p)Fe(\eta^6\text{-}C_6H_6)]^+$ will give

(a) $[(\eta^5\text{-}Cp)Fe(H)_2]$ (b) $[(\eta^5\text{-}Cp)\ Fe(H)(\ \eta^6\text{-}C_6H_6)]$

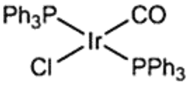
(c) $[(\eta^5\text{-}Cp)\ Fe(\eta^6\text{-}C_6H_6)]$ (d) $[(\eta^5\text{-}Cp)\ Fe(\eta^6\text{-}C_6H_7)]$

122. The μ_{eff} $[Fe(S_2CNEt_2)_3]$ changes with temperature with the involvement of two electronic states. The states are

(a) low spin $^2T_{2g}$ and high-spin $^6A_{1g}$ (b) low spin ^2E_g and high-spin $^6A_{1g}$

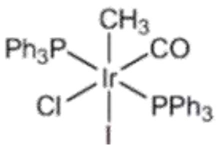
(b) low spin $^1A_{1g}$ and high-spin $^3T_{2g}$ (d) low spin $^2T_{2g}$ and high-spin $^4T_{1g}$

123. Identify the product in the reaction between

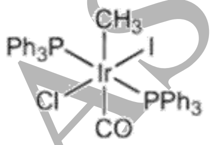


and CH_3I going at room temperature *via* S_N^2 mechanism

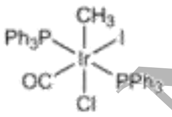
(a)



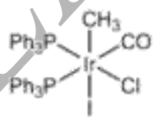
(b)



(c)



(d)



CSIR DEC 2017

124. In trigonal prismatic ligand field, the most stabilized d orbital is

(a) d_{z^2} (b) d_{xy} (c) d_{xz} (d) d_{yz}

125. Among the following species isolobal to CH_2 are

A. $CpCr(CO)_2$ B. CpCu

C. $Ni(CO)_2$ D. $Cr(CO)_4$

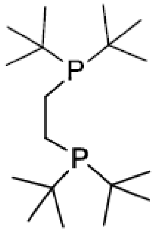
E. $Fe(CO)_4$

(a) A, C and E (b) B, C and D

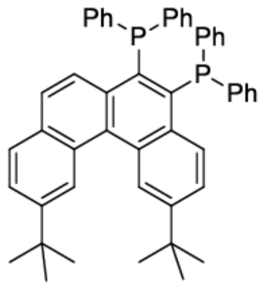
(c) B, C and E (d) A, B and D

126. In the complex [Pd(L-L)(Me)(Ph)], the bisphosphine (L-L) that does not allow reductive elimination of PhMe is

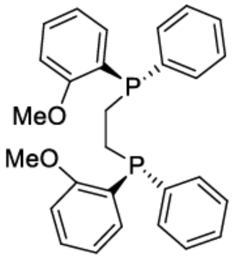
(a)



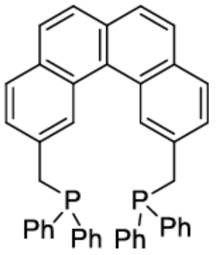
(b)



(c)



(d)



127. According to Wade's rules, the cluster type and geometry of $[Sn_9]^{-4}$, respectively, are

(a) closo and tricapped trigonal prismatic

(b) nido and monocapped square-antiprismatic

(c) arachno and heptagonal bipyramidal

(d) closo and monocapped square antiprismatic

CSIR JUNE 2018

128. The correct of C-O bond length is

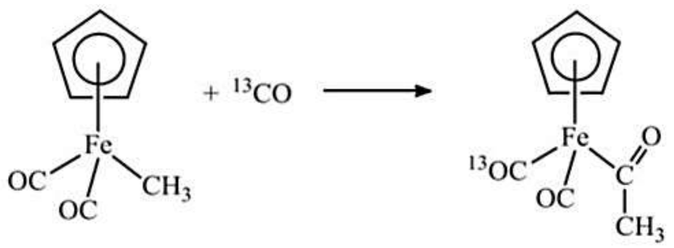
(a) $H_3B.CO > [Mn(CO)_6]^+ > [Cr(CO)_6] > [V(CO)_6]^-$

(b) $[V(CO)_6]^- > [Cr(CO)_6] > [Mn(CO)_6]^+ > H_3B.CO$

(c) $[Mn(CO)_6]^+ > H_3B.CO > [V(CO)_6]^- < [Cr(CO)_6]$

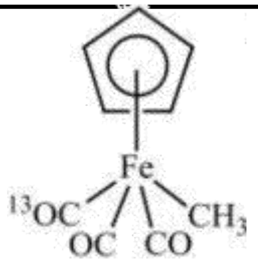
(d) $[Cr(CO)_6] > [V(CO)_6]^- > H_3B.CO > [Mn(CO)_6]^+$

129. For the following reaction

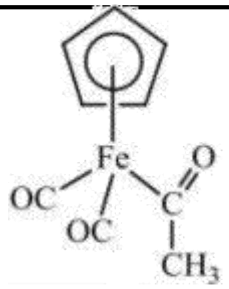


The structure of the intermediate is

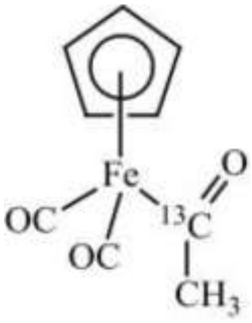
(a)



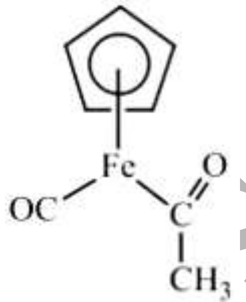
(b)



(c)



(d)



130. The correct increasing order of C-C bond length in the following molecules (A-D)

$[PtCl_3(C_2H_4)]^-$ (A) , $[Pt(PPh_3)_2 (C_2H_4)]$ (B) , $[Pt(PPh_3)_2\{C_2(CH_4)\}]$ (C)

(a) (C) < (A) < (B)
(b) (A) < (B) < (C)
(c) (B) < (C) < (A)
(d) (C) < (B) < (A)

131. Which of the following are NOT closo clusters?

$[\{Co(\eta^5\text{-}C_5H_5)\}2(C_2B_6H_8)]$ (A) $[B_4C_2H_8]$ (B) $[B_{10}H_{13}\{(Au(PPh_3)\}]$ (C) $[C_2B_8H_{10}]$ (D)

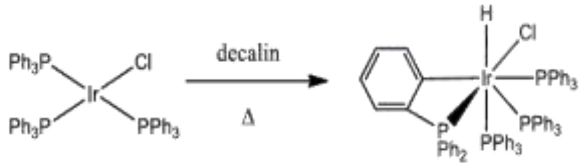
(a) (C) and (D)
(b) (A) and (B)
(c) (A) and (C)
(d) (B) and (C)

132. Identify the pair of molecules which are isoelecronic as well as isostructural from the following

$[Pd(PPh_3)_4]$ (A) , $[V(CO)_6]$ (B), $[Cr(CO)_6]$ (C) , $[Rh(PPh_3)_3Cl]$ (D), $[(\eta^5\text{-}C_5H_5)Ni(NO)]$ (E), $Ni(CO)_4$ (F)

(a) B and C
(b) A and F
(c) A and D
(d) C and E

133. For the following reaction, correct statement (S) is/are



(A) Oxidation state of iridium increases from I to II

(B) It is β-hydride elimination reaction

(C) (I) and (II) both are diamagnetic

(D) It is migratory insertion reaction

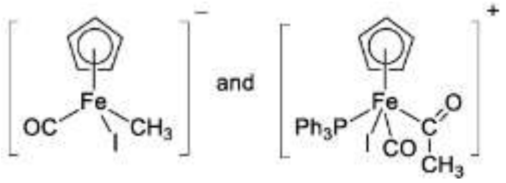
The correct answer is

(a) (A) only
(b) (A) and (C)

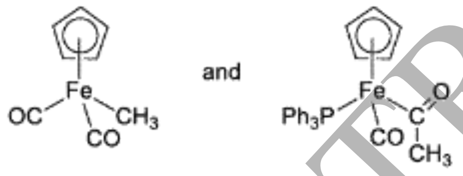
(c) (C) and (D)   (d) (B), (C), and (D)

134. The reaction of $[(\eta^5 - C_5H_5\ (Fe(CO)_2]^-$ with CH_3I gives compound A. The ^1H NMR spectrum of A show two singlets in an integrated intensity ratio of 3 : 5. Compound A upon reaction with PPh_3 give compound B. The 1H NMR spectrum of B shows 3 sets of signals in an integrated intensity ratio of 3 : 5 : 15. Compounds A and B respectively, are

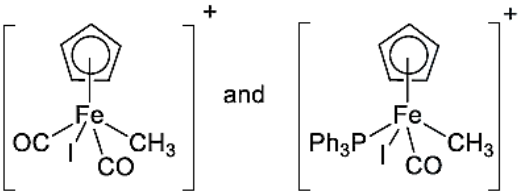
(a)



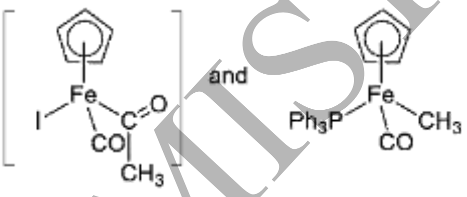
(b)



(c)



(d)



135. The structures of $[Re_2Cl_8]^{-2}$ (A) and $[Os_2Cl_8]^{-2}$ (B) are made up of two MCl_4 units. For these structure which statement is correct?

(a) (A) and (B) both have MCl_4 units eclipsed.

(b) (A) and (B) both have MCl_4 units staggered.

(c) (A) has both MCl_4 units staggered and (B) has both MCl_4 units eclipsed.

(d) (A) has both MCl_4 units eclipsed and (B) has both MCl_4 units staggered.

136. For the Wacker process, pick the correct statement (s) from the following:

(A) Pd(II) is reduced to Pd(0) by Cu(I)

(B) Pd(O) is oxidized to Pd(II) by Cu(II)

(C) Cu(II) promotes the reductive elimination

Correct answer is

(a) A and C   (b) B and C   (c) A and B   (d) B Only

CSIR DEC 2018

137. The correct order of acceptor ability of the phosphorus ligands is

(a) $PMe_3 > PPh_3 > P(OPh)_3 > PF_3$ (b) $PF_3 > P(OPh)_3 > PPh_3 > PMe_3$

(c) $PF_3 > PMe_3 > PPh_3 > P(OPh)_3$ (d) $P(OPh)_3 > PF_3 > PMe_3 > PPh_3$

138. Identify the correct statement(s) for $H_3B.CO$

(A) sp^2 hybridized orbital of B accepts the lone pair of CO.

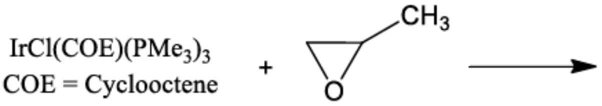
(B) Its $\bar{\upsilon}_{CO}$ value is more than that for free CO

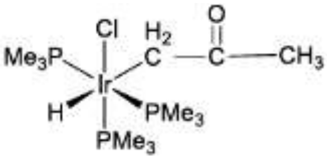
(C) Formal oxidation state of C is +4 in the compound

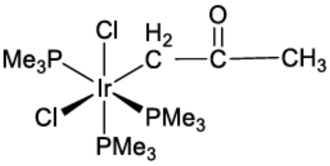
Answer is

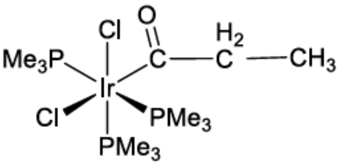
(a) A and B   (b) B only   (c) A only   (d) A and C

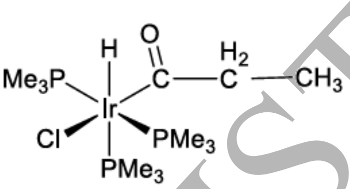
139. The product for the reaction given below is



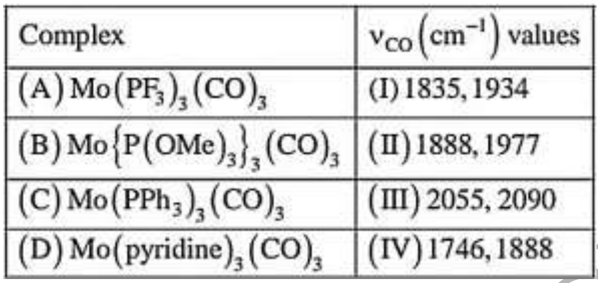
(a)


(b)


(c)


(d)


140. Match the following complexes with their v_{CO} stretching frequency



Complex	$v_{CO}\left(cm^{-1}\right)$ values
(A) $Mo(PF_3)_3(CO)_3$	(I) 1835, 1934
(B) $Mo\{P(OMe)_3\}_3(CO)_3$	(II) 1888, 1977
(C) $Mo(PPh_3)_3(CO)_3$	(III) 2055, 2090
(D) $Mo(pyridine)_3(CO)_3$	(IV) 1746, 1888

The correct match is

(a) A-I, B-IV, C-II, D-III
(c) A-IV, B-III, C-I, D-II
(b) A-III, B-II, C-I, D-IV
(d) A-I, B-II, C-III, D-IV

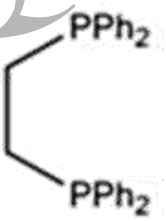
141. The VCN in $[Fe(CN)_6]^{-3}$ (A) and $[Fe(CN)_6]^{-4}$ (B) and V_{co} in $[Cr(CO)_3(NH_3)_3]$ (C) and $[Cr(CO)_6]$ (D) are compared below. The pair with correct order is

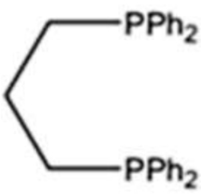
(a) A > B ; C > D (b) A > B ; C < D (c) A < B ; C > D (d) A < B ; C < D

142. The cluster type and geometry of the species $[Rh_9P(CO)_{21}]^{-2}$ are

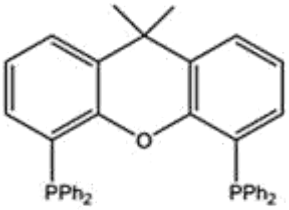
(a) closo, tricapped trigonal prism
(b) arachno, trigonal prism
(c) nido, capped square antiprism
(d) nido, bicapped trigonal prism

143. Hydroformylation of 1-propene with $[HRh(CO)L_2]$leads to linear and branched formylated products. The linear hydroformylated product is formed with highest selectivity when 'L' in the rhodium complex is

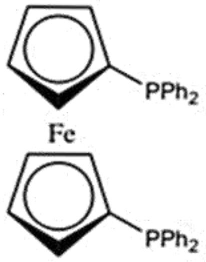
(a)


(b)


(c)



(d)



144. The hydrocarbon having an analogous structure to that of P_4O_6 is

(a) $[(CH)_4\ (\mu\text{-}CH_2)_6]$
(c) $[(CH_2)_4\ (\mu\text{-}CH)_6]$
(b) $[(CH)_6\ (\mu\text{-}CH_2)_4]$
(d) $[(CH_2)_4\ (\mu\text{-}CH)_4]$

CSIR JUNE 2019

145. The number of Ni-Ni bonds in $[CpNi(\mu\text{-}PPh_2)]_2$ complex obeying the 18 electron rule is

(a) 0 (b) 1 (c) 2 (d) 3

146. For the reaction of trans-[IrX(CO)(PPh3)2] (X= F, Cl , Br , I) with O2, correct order of variation of rate with X is

(a) Br > I > F > Cl (b) F > Cl > Br > I (c)F ≈ Cl ≈ Br ≈ 1 (d) I > Br > Cl > F

147. The organic species isolobal to $[Fe(CO)_2(PPh_3)]^-$ is

(a) CH_2^+ (b) CH^- (c) CH_3 (d) CH

148. The correct statements about $[Ru_6C(CO)_{17}]$ cluster from the following

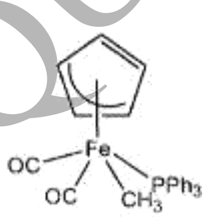
(1) it is an 86 electron cluster
(2) it is a closo structure type
(3) its shape is capped square pyramid
(4) carbon interacts with all the Ru centres in the cluster

are

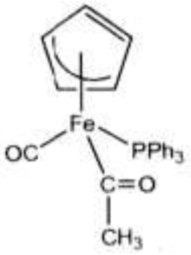
(a) 1, 2, 3 and 4 (b) 1 and 2 only (c) 1, 2 and 3 (d) 1, 2 and 4

149. A plausible structure of the intermediate involved in the following reaction

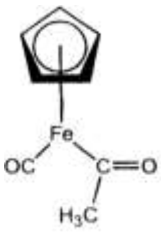
$[Fe(\eta^5\text{-}C_5H_5)(CH_3)(CO)_2] + PPh_3 \rightarrow [Fe(\eta^5\text{-}C_5H_5)(C(=O)CH_3)(CO)(PPh_3)]$



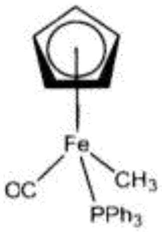
(a)



(b)

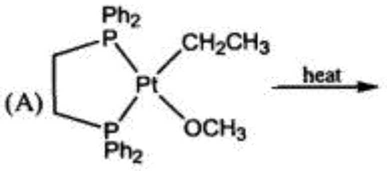


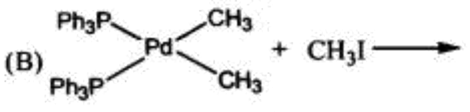
(c)

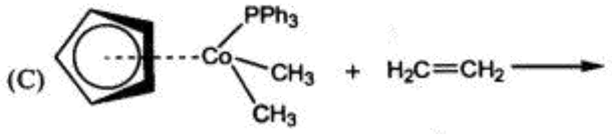


(d)

150. Consider the following reactions:







The reaction(s) which will NOT produce ethane as a product is/are

(a) A (b) B (c) C (d) A and C

151. Considering σ-bonding only, in the MO diagram of a metal complex with trigonal bipyramidal (TBP) geometry, the d-orbitals which remain non-bonding are

(a) dz^2 and d_{xz} (b) d_{xz} and d_{yz} (c) $d_{x^2-y^2}$ and d_{xy} (d) dz^2 and d_{yz}

CSIR DEC 2019

152. The expected number of co bands in the IR spectra of fac-$[Mo(PPh_3)_2(CO)_3]$ and trans-[Mo(PPh3)2(CO)4] are, respectively

(a) one and one (b) Two and two (c) two and one (d) three and one

153. The most stable vanadium species in aqueous medium is

(a) $[V(H_2O)_5(OH)]^{+2}$ (b) $[VO(H_2O)_5]^{+2}$ (c) $[VO(H_2O)_5]^{+}$ (d)$[V(H_2O)_4(OH)_2]^{+2}$

154. The correct order of metal-carbon distance is

(a) $Fe(\eta^5\text{-}Cp)_2 > Co(\eta^5\text{-}Cp)_2 > Ni(\eta^5\text{-} Cp)_2$ (b) $Fe(\eta^5\text{-}Cp)_2 > Ni(\eta^5\text{-} Cp)_2 > Co(\eta^5\text{-}Cp)_2$

(c) $Ni(\eta^5\text{-} Cp)_2 > Fe(\eta^5\text{-}Cp)_2 > Co(\eta^5\text{-}Cp)_2$ (d) $Ni(\eta^5\text{-}Cp)_2 > Co(\eta^5\text{-}Cp)_2 > Fe(\eta^5\text{-}Cp)_2$

155. The rate-determining step in the catalytic synthesis of acetic acid by Monsanto process is

(a) oxidative addition of CH_3I to $[RhI_2(CO)_2]^-$

(b) migration of CH_3 group to CO of $[RhI_3(CO)_2(CH_3)]^-$

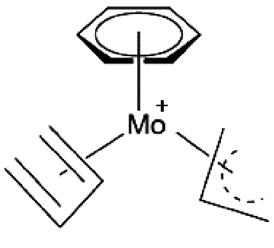
(c) loss of CH_3COI from $[RhI_3(CO)_2(COCH_3)]^-$

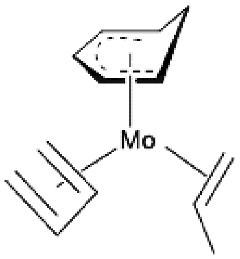
(d) coordination of CO to $[RhI_3CO(COCH_3)]^-$

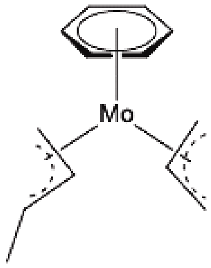
156. The cluster types of $[Fe_5(CO)_{14}N]^-$ and $[Co_6(CO)_{13}N]^-$ are, respectively,

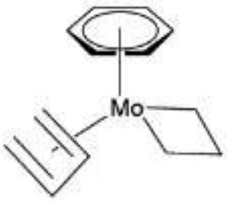
(a) nido-, nido (b) nido-, closo (c) closo-, nido (d) closo-, closo

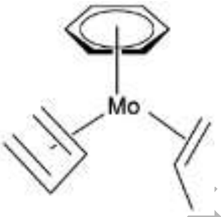
157. The main product of nucleoplallic attack of H^- on the complex ion given below is



(a)


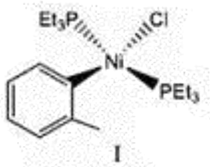
(b)


(c)


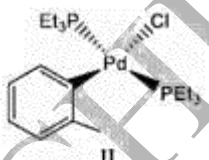
(d)


CSIR 2020

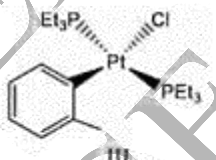
158. The order of rate of substitution of chloride by pyridine (in ethanol) in the following complexes is



I



II



III

(a) I > II > III (b) I ≈ III ≈ II (c) I > II ≈ III (d) I < II ≈ III

159. Among the following complexes, the one showing the highest rate of substitution of a CO ligand on heating with one equivalent of PPh3 in decalin, is

(a) $(\eta^5\text{-}C_5H_5)Mn(CO)_3$ (b) $(\eta^5\text{-}C_5Ph_5)Mn(CO)_3$

(c) $(\eta^5\text{-}C_5Me_5)Mn(CO)_3$ (d) $(\eta^5\text{-indenyl})Mn(CO)_3$

160.The correct electronic configuration of frontier MO's of $Mn(\eta^5\text{-}C_5Me_5)$ is

(a) $e_{2g}^2a_{1g}^1e_{1g}^2$ (b) $e_{2g}^4a_{1g}^1$ (c) $e_{2g}^3a_{1g}^2$ (d) $a_{1g}^2e_{2g}^3$

161. On heating $[Mo(N_2)_2(PMe_2Ph)_4]$ and $[ReCl(N_2)(PMe_2Ph)_4]$, the products formed are respectively

(a) $[(\eta^6\text{-}PhPMe_2)Mo(PMe_2Ph)_3]$ and $[(\eta^6\text{-}PhPMe_2)Re(PMe_2Ph)_3]Cl$

(b) $[(PMe_2Ph)_4Mo(\mu\text{-}N_2)_2Mo(PMe_2Ph)_4]$ and $[(PMe_2Ph)_4Re(\mu\text{-}Cl)_2Re(PMe_2Ph)_4]$

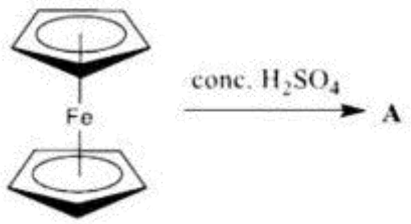
(c) $[(\eta^6\text{-}PhPMe_2)Mo(PMe_2Ph)_3]$ and $[(PMe_2Ph)_4Re(u\text{-}Cl)_2Re(PMe_2Ph)_4]$

(d) $[(PMe_2Ph)_4Mo(u\text{-}N_2)_2Mo(PMe_2Ph)_4]$ and $[(\eta^6\text{-}PhPMe_2)Re(PMe_2Ph)_3]Cl$

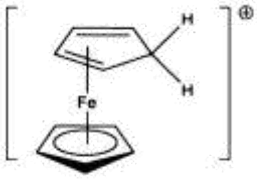
162. The geometry/shape of the Fe4 core of the cluster $[Fe_4C(CO)_{12}]^{-2}$ is

(a) tetrahedron (b) square pyramid (c) butterfly (d) trigonal bipyramid

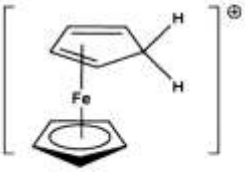
163. The product A of the following reaction is



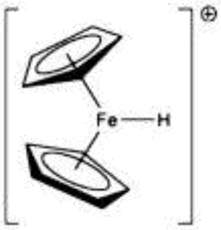
(a)



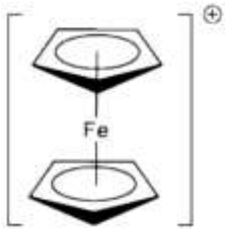
(b)



(c)



(d)



164. The number of peaks with relative intensities observed in the ^{1}H NMR spectra of $[(Cp)_2Fe(CO)_2]$ at +30 °C and -80 °C in diethyl ether are, respectively

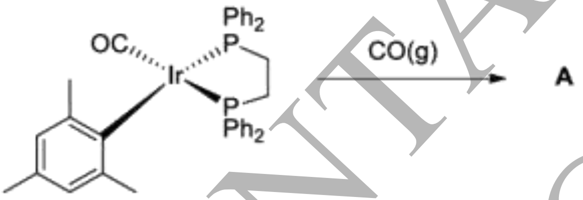
(a) two peaks (1 : 1) and four peaks (5 : 2 : 2 : 1)

(b) one peak and two peaks (1 : 1)

(c) two peaks (1 : 1) at both the temperatures

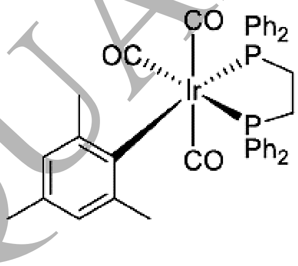
(d) one peak and four peaks (5 : 2 : 2 : 1)

165. The infrared (IR) spectrum of the product A for the following reaction

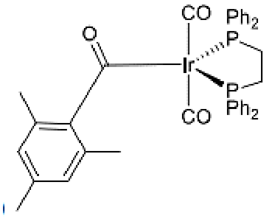


shows three STRONG bands at 1986, 1935 and 1601 cm^{-1} . The correct structure of 'A' is

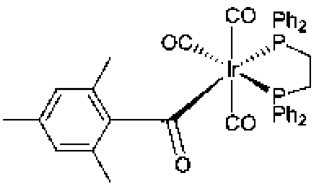
(a)



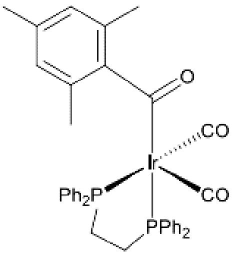
(b)



(c)



(d)



CSIR JUNE 2021

166. Consider following statement(s) in the context of NO and CO ligands

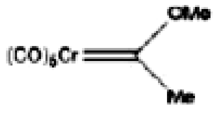
A. In the bent mode, NO donates three electrons to the metal center.

B. In IR spectrum, the ν_{NO} for the bent nitrosyl ligand typically lies between 1525 and 1690 cm^{-1}

C. The HOMO of NO and CO are π^* and σ orbitals, respectively

(a) A only (b) B and C (c) A and C (d) A and B

167. Consider the following statement (s) in the context of organometallic complex (x)



X

A. The carbene ligand donates two electrons to the metal and accepts d electrons to make a Pibond

B. The C (carbene) is nucelophilic

C. Rotation around the Cr = c(OME)Me double bond has low barrier (< 10 kcal/mol)

Correct statement(s) is/are:

(a) A and B (b) A only (c) A and C (d) B and C

168. The correct geometries for the metal carbonyl clusters, A-C

A. $[Ru_6(CO)_{17}B]^-$ B. $[Os_6(CO)_{18}P]^-$ C. $[Os_4(CO)_{16}]$ are

(a) A: pentagonal bipyramidal, B: trigonal prismatic, and C:tetrahedral

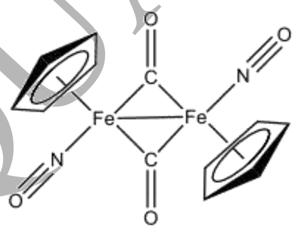
(b) A: pentagonal bipyramidal, B: octahedral, and C: square

(c) A: octahedral, B: trigonal prismatic, and C: tetrahedral

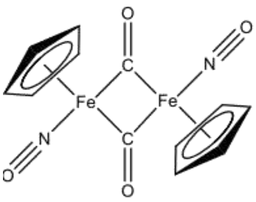
(d) A: octahedral, B: trigonal prismatic, and C: square

169. Identify the thermodynamically stable structure of $[(\eta^5 -C2H5)Fe(\mu^2 -CO)(NO)]^2$

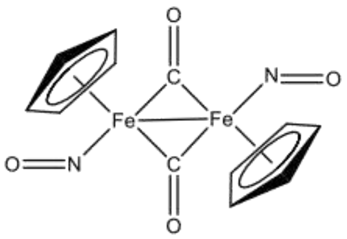
(a)



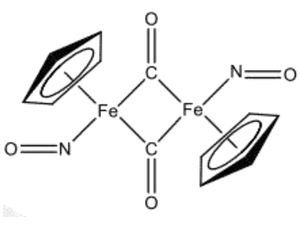
(b)



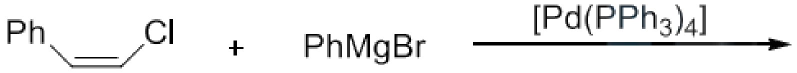
(c)

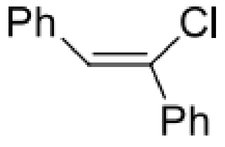


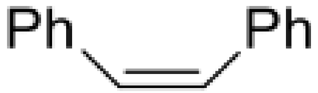
(d)

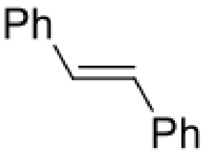


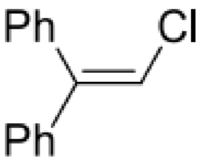
170. The major product formed in the following reaction



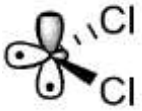
(a)


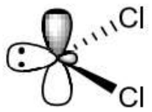
(b)


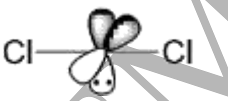
(c)


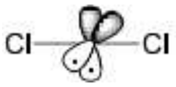
(d)


171. The structure of the reactive intermediate generated by the reaction of CHCl3 and KOH is

(a)


(b)


(c)


(d)


•••••••

ANSWER KEY

ORGANOMETALLIC COMPOUNDS

1	**d**	31	**a**	61	**?**	91	**d**	121	**d**	151	**b**
2	**c**	32	**d**	62	**b**	92	**d**	122	**a**	152	**c**
3	**b**	33	**b**	63	**a**	93	**a**	123	**a**	153	**b**
4	**a**	34	**a**	64	**a**	94	**a**	124	**d**	154	**d**
5	**c**	35	**c**	65	**c**	95	**d**	125	**c**	155	**a**
6	**d**	36	**c**	66	**a**	96	**c**	126	**d**	156	**b**
7	**a**	37	**d**	67	**b**	97	**d**	127	**b**	157	**?**
8	**a**	38	**c**	68	**d**	98	**b**	128	**b**	158	**a**
9	**b**	39	**c**	69	**a**	99	**c**	129	**d**	159	**d**
10	**d**	40	**b**	70	**c**	100	**b**	130	**d**	160	**b**
11	**a**	41	**b**	71	**a**	101	**c**	131	**d**	161	**c**
12	**d**	42	**d**	72	**b**	102	**b**	132	**b**	162	**c**
13	**a**	43	**b**	73	**a**	103	**a**	133	**b**	163	**c**
14	**a**	44	**a**	74	**a**	104	**a**	134	**b**	164	**a**
15	**b**	45	**d**	75	**a**	105	**a**	135	**d**	165	**d**
16	**a**	46	**d**	76	**a**	106	**c**	136	**d**	166	**b**
17	**b**	47	**a**	77	**a**	107	**b**	137	**b**	167	**c**
18	**b**	48	**c**	78	**c**	108	**c**	138	**b**	168	**d**
19	**a**	49	**a**	79	**a**	109	**a**	139	**b**	169	**b**
20	**b**	50	**b**	80	**a**	110	**b**	140	**b**	170	**b**
21	**b**	51	**b**	81	**b**	111	**a&c**	141	**b**	171	**b**
22	**d**	52	**c**	82	**a**	112	**b**	142	**c**		
23	**b**	53	**c**	83	**c**	113	**b**	143	**c**		
24	**d**	54	**a**	84	**d**	114	**c**	144	**a**		
25	**c**	55	**a**	85	**d**	115	**c**	145	**a**		
26	**a**	56	**a**	86	**b**	116	**b**	146	**d**		
27	**a**	57	**c**	87	**c**	117	**b**	147	**d**		
28	**a**	58	**c**	88	**b**	118	**c**	148	**d**		
29	**a**	59	**b**	89	**a**	119	**a**	149	**c**		
30	**b**	60	**b**	90	**a**	120	**a**	150	**c**		

3

Main Group Elements

CSIRJUNE 2011

1. The correct order of stability of difluorides is:

(a) $GeF_2 > SiF_2 > CF_2$
(b) $CF_2 > SiF_2 > GeF_2$
(c) $SiF_2 > GeF_2 > CF_2$
(d) $CF_2 > GeF_2 > SiF_2$

2. Alkali metal superoxides are obtained by the reaction of

(a) Oxygen with alkali metals in liquid ammonia.
(b) Water with alkali metals in liquid ammonia
(c) H_2O_2 with alkali metals.
(d) H_2O_2 with alkali metals in liquid ammonia.

3. Match List-I (compounds) with List-II (application) and select the correct answer using the codes given below the lists.

List 1	List 2
(A) Tri sodium phosphate	(i) Plasticizer
(B) Tri aryl phosphates	(ii) Water softener
(C) Tri ethyl phosphate	(iii) Toothpaste
(D) Calcium hydrogen phosphate	(iv) Insecticides

(a) (A)-ii (B)-i (C)-iv (D)-iii
(b) (A)-i (B)-ii (C)-iv (D)-iii
(c) (A)ii- (B)-iii (C)-iv (D)-i
(d) (A)-iii (B)-i (C)-ii (D)-iv

4. Among the following, the number of anhydrides of acids are

CO, NO, N_2O_3,B_2O_3,N_2O_5, SO_3 and P_4O_{10}

(a) 3
(b) 4
(c) 5
(d) 6

CSIR DEC 2011

5. The correct statement regarding closo-{BnHn} species is:

(a) it always has-2 charge

(b) it always has +2 charge.

(c) it is a neutral species

(d) it is more reactive than nido , arachno, and hypo-boranes

6. Lewis acidity of BCl_3, BPh_3 and BMe_3 with respect to pyridine follows the order

(a)BCl_3> BPh_3> BMe_3

(b)BMe_3> BPh_3> BCl_3

(c)BPh_3>BMe3 > BCl_3

(d)BCl_3>BMe_3> BPh_3

7. Among the following pairs

(1) oxygen-sulfur

(2) nitrogen -phosphorus

(3) phosphorus arsenic

(4) chlorine- iodine

Those in which the first ionization energies differ by more than 300 kJ mole are:

(a) (1) and (3) only

(b) (1) and (2) only

(c) (2) and (3) only

(d) (3) and (4) only

8. The reaction between NH_4Br and Na metal in liquid ammonia (solvent) results in the products

(a) NaBr, HBr

(b) NaBr, H_2

(c) H_2, HBr

(d) HBr, H_2

9. The material that exhibits the highest electrical conductivity among the following sulfur - nitrogen compounds is

(a) S_4N_4

(b) S_7NH

(c) S_2N_2

(d) $(SN)_x$

10. The final product (s) of the reaction $P(OR)_3$ +R'X is/are

(a) $R'PO(OR)_2$ and RX

(b) $[R'PO(OR)_2]X$

(c) $[R'RPO_2(OR)]X$

(d) ROR′and $P(OR)_2X$

11. A Sodalite cage in zeolites is

(a) a truncated tetrahedron

(b) an icosahedron

(c) a truncated octahedron

(d) a dodecahedron

12. The styx code of B_4H_{10} is:

(a) 4120

(b) 4220

(c) 4012

(d) 3203

13. Bayer's process involves.

(a) Synthesis of B_2H_6 from $NaBH_4$

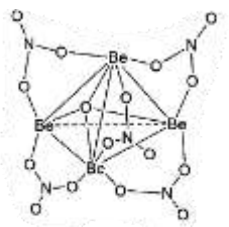
(b) Synthesis of NaBH4 from borax

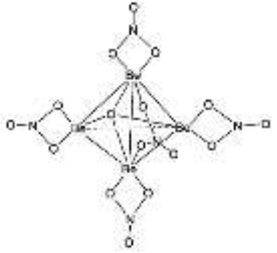
(c) Synthesis of $NaBH_4$ from B_2H_6

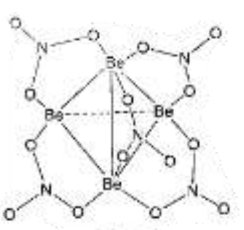
(d) Synthesis of $B_3N_3H_6$ from B_2H_6

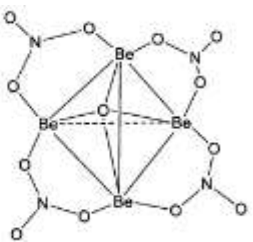
CSIR JUNE 2012

14 The correct structure of beryllium nitrate is :

(a) 

(b) 

(c) 

(d) 

15. The strength of pπ-dπ bonding in E-O (E = Si, P, S and CI) follows the order

(a) Si-O>P-O>S-O>Cl-O (b) P-O>Si-O>S-O>Cl-O

(c) S-O>Cl-O>P-O>Si-O (d) Cl-O>S-O>P-O>Si-O

16. Among the halides, NCl_3 (A), PCl_3 (B) and $AsCl_3$ (C), those which produce two different acids.

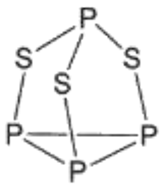
(a) A and B (b) A and C (c) B and C (d) A, B and C

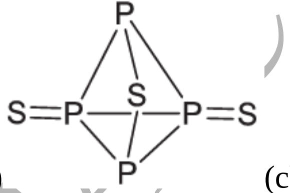
17. The most used acid catalyst in oil industry and the relevant process are respectively

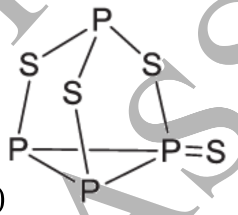
(a) Alumino phosphate and reforming (b) Alumino silicate and cracking

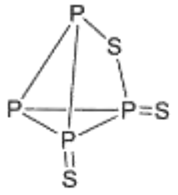
(c) Alumino silicate and reforming (d) Alumino phosphate and cracking.

18. The correct structure of P_4S_3 is:

(a) 

(b) 

(c) 

(d) 

19. Low oxidation state complexes are often air-sensitive, but are rarely water sensitive because

(a) Air is reducing in nature while water is inert

(b) Both air and water are oxidizing in nature

(c) Both air and water are not acceptors

(d) Complexes with low oxidation states will easily lose electrons to O_2 but will not bind to a π–donor molecule like H_2O.

CSIR DEC 2012

20. For the deposition of Pb by electroplating, the best suited compound among the following is
(a) $PbCl_2$ (b) $PbSO_4$ (c) $Pb(Et)_4$ (d) $Pb(BF_4)_2$

21. The electronegativity differences is the highest for the pair

(a) Li, Cl (b) K, F (c) Na, Cl (d) Li, F

22. Structure of a carborane with formula, $C_2B_4H_8$, is formally derived from

(a) Closo-borane (b) Nido-borane (c) Arachno-borane (d) Conjuncto-borane

23. Boric acid is a weak acid in aqueous solution. But its acidity increases significantly in the presence of ethylene glycol, because

(a) ethylene glycol releases additional H^+

(b) $B(OH)_4^-$ is consumed in forming a compound with ethylene glycol.

(c) ethylene glycol neutralizes H^+ released by boric acid.

(d) Boric acid dissociates better in the mixed-solvent.

24. Silicates with continuous 3D frame work are

(a) Neso-silicates (b) Soro-silicates (c) Phyllo-silicates (d) Tecto-silicates

CSIR JUNE 2013

25. Which of the following pairs has the highest difference in their first ionization energy?
(a) Xe, Cs (b) Kr, Rb (c) Ar, K (d) Ne, Na

26. Which of the following is used as propellant for whipping creams?

(a) N_2O (b) NO (c) N_2O_3 (d) N_2O_5

27. Flame proof fabrices contain

(a) $H_2NC(O)NH_2.Na_2SO_4$ (b) $H_2NC(S)NH_2.Na_2SO_4$

(c) $H_2NC(O)NH_2.H_3PO_4$ (d) $H_2NC(S)NH_2.H_3PO_4$

28. Among the oxides of nitrogen, N_2O_3 , N_2O_4 ,and N_2O_5 the compound(s) having N-N bond is/are

(a) N_2O_4 and N_2O_5 (b) N_2O_3 and N_2O_5

(c) N_2O_3 and N_2O_4 (d) N_2O_5 only

29. Identify the pairs in which the covalent radii of elements are almost similar

(A) Nb, Ta (B) Mo, W (C) La, Lu (D) Sc, Y

(a) A and B only (b) A and C only

(c) B and C only (d) A, B and C only

30. The correct equilibrium order for the interconversion of different forms of SiO_2 is

(a) Tridymite ↔ quartz ↔cristobalite ↔ liquid SiO_2

(b) quartz ↔Tridymite ↔cristobalite ↔liquid SiO_2

(c) quartz↔cristobalite ↔ tridymite↔liquid SiO_2

(d) cristobalite ↔ tridymite ↔ quartz ↔liquid SiO_2

CSIR DEC 2013

31. The reaction of $FeCl_3.6H_2O$ with $SOCl_2$ yields.
(a) $FeCl_2$ (s), SO_2 (g) and HCl (g) (b) $FeCl_3$(s), SO_2 (g) and HCI (l)

(c) $FeCl_2$ (S), SO_2(s) and HCl (g) (d) $FeCl_3$(s), SO_2 (g) and HCl(g)

32. Among the molten alkali metals, the example of an immiscible pair (in all proportions)is

(a) K and Na (b) K and Cs (c) Li and Cs (d) Rb and Cs

33. Treatment of ClF_3 with SbF_5 leads to the formation of a/an

(a) polymeric material (b) covalent cluster (c) ionic compound (d) lewis acid-base adduct

34. The reason for the chemical inertness of gaseous nitrogen at room temperature is best given

(a) high bonding energy only (b) electronic configuration

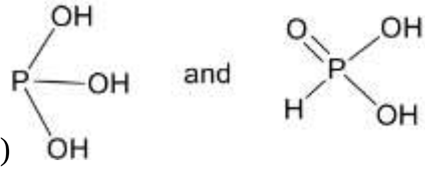
(c) HOMO-LUMO gap only (d) high bond energy and HOMO-LUMO gap.

35. Commonly used scintillator for measuring radiation is

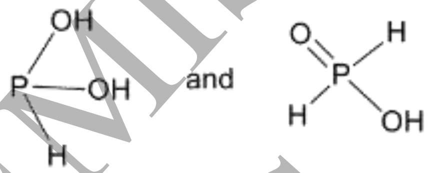
(a) Nal(AI) (b) Nal(TI) (c) CsI(TI) (d) Csl(AI)

36. Two tautomeric forms of phosphorus acid are

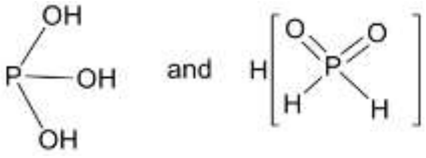
(a)



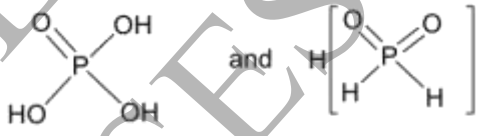
(b)



(c)

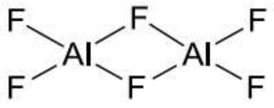


(d)

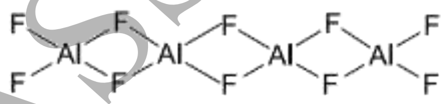


37. The solid state structure of aluminum fluoride is

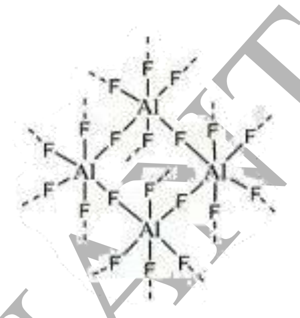
(a)



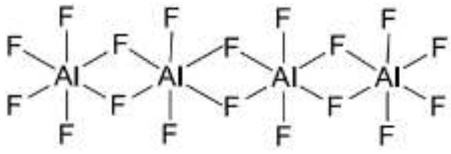
(b)



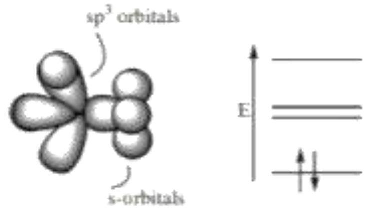
(c)



(d)



38. The orbital interactions shown below represent



(a) CH-Al interactions in $Al_2(CH_3)_6$

(b) B-H interactions in B_2H_6

(c) CH-Li interaction in $Li_4(CH_3)_4$

(d) CH_3CH_2-Mg interactions in $EtMgBr.(OEt_2)_2$

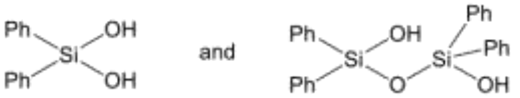
39. In a specific reaction, hexachlorocyclotriphosphazene, $N_3P_3Cl_6$ was reacted with a metal fluoride to obtain mixed halo derivatives namely $N_3P_3Cl_3F$ (A), $N_3P_3Cl_4F$ (B), $N_3P_3Cl_3F_3$(C), $N_3P_3Cl_2F_4$ (D),$N_3P_3ClF_5$ (E). Compositions among these which can give isomeric products are
    (a) A, B and C (b) B, C and D (c) C, D and E (d) E, A and B
40. Xenon forms several fluorides and oxofluorides which exihibit acidic behaviour. The correct sequence of descending Lewis acidity among the given species is represented by
    (a) $XeF_6 > XeOF_4 > XeF_4 > XeO_2F_2$ (b) $XeOF_4 > XeO_2F_2 > XeOF_4 > XeF_6$
    (c) $XeF_4 > XeO_2F_2 > XeOF_4 > XeF_6$ (d) $XeF_4 > XeF_6 > XeOF_4 > XeO_2F_2$
41. Number of isomeric derivatives possible for the neutral closo-carborane, $C_2B_{10}H_{12}$ is
    (a) three (b) two (c) four (d) six
42. For higher boranes 3c-2e 'BBB' bond may be a part of their structures. In B_5H_9, the number of such electron deficient bond(s) present is/are
    (a) four (b) two (c) zero (d) one

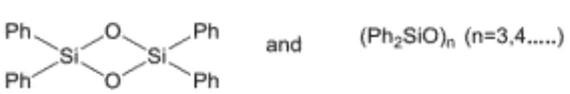
CSIR JUNE 2014

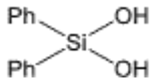
43. Reactions of elemental as with hot and conc. HNO_3, and H_2SO_4 respectively, give
    (a) As_4O_6 and $As_2(SO_4)_3$ (b) $As(NO_3)_5$ and $As_2(SO)_3$
    (c) As_4O_6 and H_3AsO_4 (d) H_3AsO_4 and As_4O_6
44. Chromite ore on fusion with sodium carbonate gives
    (a) Na_2CrO_4 and Fe_2O_3 (b) $Na_2Cr_2O_7$ and Fe_2O_3
    (c) Cr_2 $(CO_3)3$ and $Fe(OH)_3$ (d) Na_2CrO_4 and $Fe_2(CO_3)_3$
45. The correct order of decreasing electronegativity of the following atoms is,
    (a) As > Al> Ca >S (b) S> As > Al> Ca (c) Al> Ca >S>As (d) S> Ca >As > Al
46. The correct order of the size of S, S^{2-}, S^{2+} and S^{4+} species is,
    (a) $S > S^{2+} > S^{4+} > S^{2-}$ (b) $S^{2+} > S^{4+} > S^{2-} > S$ (c) $S^{2-} > S > S^{2+} > S^{4+}$ (d) $S^{4+} > S^{2-} > S > S^{2+}$

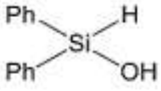
CSIR DEC 2014

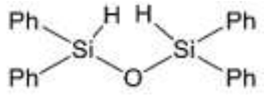
47. The reaction between SbF_5 and two equivalents of HF leads to the formation of
    (a) $H_2SbF_3 + 2F_2$ (b) $HSbF_2 + 3F_2$ (c) $SbF_3 + H_2 + 2F_2$ (d) $[SbF_6]^- [H_2F]^+$
48. Among F-, Na^+, O^{2-} and Mg^{2+} ions, those having the highest and the lowest ionic radii respectively are
    (a) O^{2-} and Na^+ (b) F^- and Mg^{2+} (c) O^{2-} and Mg^{2+} (d) Mg^{2+} and O^{2-}
49. The reaction between diphenyldichlorosilane and water in 1:2 molar ratio gives product A which on heating above 100°C yields a cyclic or polymeric product B. The products A and B respectively, are

(a) 

(b) 

(c) 

and $(Ph_2SiO)_n$ (n=3,4.....)
(d) 

and 

50. A borane (X) is reacted with ammonia to give a salt of borohydride (Y). The ^{11}B NMR spectrum of Y consists of a triplet and a quintet. The borane X is

(a) B_2H_6 (b) B_3H_9 (c) B_4H_8 (d) B_5H_9

51. 12-Crown-4 binds with the alkali metal ions in the following order :
$Li^+ >> Na^+ > K^+ > Cs^+$. It is due to the

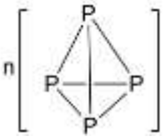
(a) Right size of cation crown ether
(b) Change in entropy being positive
(c) Conformational flexibility of crown ether
(d) Hydrophobicity of crown ether

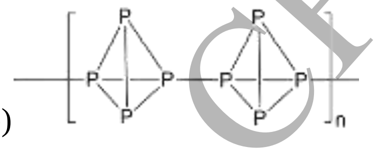
52. The main products of the reaction of equimolar quantities of XeF_6 with $NaNO_3$ are

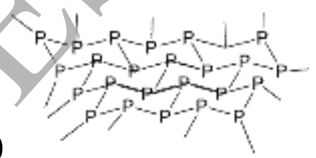
(a) $XeOF_4$,NaF and NO_2F
(b) XeO_2F_2, NaF, NOF and F_2
(c) $XeOF_4$, $NaNO_2$ and F_2
(d) XeF_4, $NaNO_2$, and F_2O

CSIR JUNE 2015

53. All forms of phosphorus upon melting, exist as

(a) 

(b) 

(c) $n(P \equiv P)$
(d) 

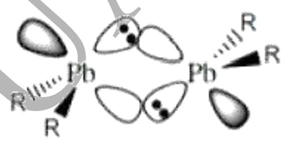
54. The correct set of pseudo halide anions is

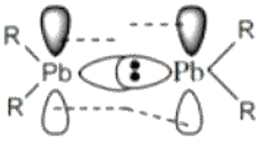
(a) CN^- , ClO_4^-, BF_4^-, PF_6^-
(b) SCN^-, PO^{-3}_4, $H_2PO^-_4$,N^-_3
(c) N^-_3, NO^-_3, HSO_4 AsF^-_6
(d) CN^-, N^-_3 , SCN^-, NCN^{2-}

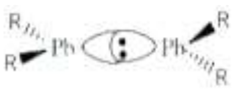
55. The oxoacid of phosphorus having P atoms in +4, +3, and +4 oxidation states respectively, is

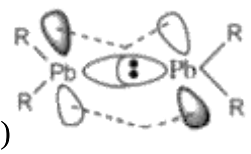
(a) $H_5P_3O_{10}$ (b) $H_5P_3O_7$ (c) $H_5P_3O_8$ (d) $H_5P_3O_9$

56. Considering the inert pair effect on lead, the most probable structure of PbR_2 [R =2.6-C_6H_3 (2. 6 – $Pr_2C_6H_3)_2$ is

(a) 

(b) 

(c) 

(d) 

CSIR DEC 2015

57. The order of increasing Bronsted acidity for boron hydrides is

(a) $B_5H_9<B_6H_{10}<B_{10}H_{14}$
(b) $B_{10}H_{14}<B_5H_9<B_6H_{10}$
(c) $B_6H_{10}<B_{10}H_{14}<B_5H$
(d) $B_{10}H_{14}<B_6H_{10}<B_5H_9$

58. The ring size and the number of linked tetrahedral present in $[Si_6O_{18}]^{-12}$ are, respectively

(a) 6 and 6 (b) 12 and 6 (c) 12 and 12 (d) 6 and 12

59. Consider the following reaction :

$N_3P_3C_{l6}$ + 6HNMe$_2$ →$N_3P_3Cl_3(NMe_2)_3$ +3 $Me_2NH.HCI$ [A]

The number of possible isomers for [A] is

(a) 4 (b) 3 (c) 2 (d) 5

60. The reaction of BCl_3 , with NH_4Cl gives product A which upon reduction by $NaBH_4$ gives product B. Product B upon reacting with HCI affords compound C, which is

(a) $Cl_3B_3N_3H_9$ (b) $[ClBNH]_3$ (c) $[HBNH]_3$ (d) $(ClH)_3B_3N_3(ClH)_3$

61. Protonated form of ZSM-5 catalyzes the reaction of ethene with benzene to produce ethylbenzene. The correct statement for this catalytic process is

(a) alkyl carbocation is formed (b) carbanion is formed

(c) benzene converted to $(C_6H_5)^+$ group (d) vinyl radical is formed

CSIR JUNE 2016

62. The numbers of P-S and P-P bonds in the compound P_4S_3 are, respectively

(a) 6 and 3 (b) 4 and 3 (c) 3 and 6 (d) 6 and 2

63. The compound which dissolves in $POCl_3$ to give a solution with highest chloride ion concentration, is

(a) Et_3N (b) KCl (c) $FeCl_3$ (d) $SbCl_5$

CSIR DEC 2016

64. The metal iodide with metallic lustre and high electrical conductivity is

(a) NaI (b) CdI_2 (c) LaI_2 (d) BiI_3

65. Consider the following statements for KC_8:

(A) It is paramagnetic

(B) It has eclipsed layer structure

(C) Its electrical conductivity is greater than that of graphite.

The correct answer is

(a) A and B (b) A and C (c) B and C (d) A, B and C

66. Among the following, choose the correct products that are formed in the reaction of S_2 Cl_2 with ammonia in CCl_4 NH_4Cl(A) , S_4N_4 (B) , S_8 (C) , and $S_3N_3Cl_3$ (D).

(a) A, B and C (b) A, B and D (c) B, C and D (d) A, C and D

67. The final product(s) of the reaction of arachno borane, B_4H_{10} with NMe_3 is/are

(a) $[BH_3.NMe,]$ and $[B_3H_7 . NMe_3]$ (b) $[BH_2(NMe_3)_2]^+ [B_3H_8]^-$

(c) $[B_4H_{10}.NMe_3]$ (d) $[B_4H_{10}.NMe_3]$ and $[BH_2(NMe_3)_2]^+ [B_3H_8]^-$

CSIR JUNE 2017

68. Both potassium and sulfuric acid form intercalation compounds with graphite. The graphite layers are
    (a) reduced in both the cases
    (b) oxidized in both the cases
    (c) oxidized in the case of potassium and reduced in the case of sulphuric acid
    (d) reduced in the case of potassium and oxidized in the case of sulphuric acid
69. Addition of two electrons to the bismuth cluster Bi_5^{+3} results in a change of structure type from
    (a) closo to nido (b) nido to arachno
    (c) closo to arachno (d) arachno to hypho
70. The compound N_2F_2 has two isomers. Choose the correct option from the following:
    (a) both isomers possess a σ_v plane
    (b) both isomers possess σ_h plane
    (c) one isomer has a σ_h plane while the other has a σ_v plane
    (d) none of them have a σ_h plane

CSIR DEC 2017

71. The first ionization energy is the lowest for
    (a) Br (b) Se (c) P (d) As
72. Choose the incorrect statement for the phosphomolybdate anion $[PMO_{12}O_{40}]^{-3}$
    (a) It has a Keggin structure.
    (b) Phosphorus is in +5 oxidation state.
    (c) It is extremely basic.
    (d) It forms crystalline precipitates with $[R_4N]^+$ (R = bulky alkyl or aryl group)

CSIR JUNE 2018

73. The structure of $CaB_6$is close to that of
    (a) Cesium chloride (b) Nickel arsenide (c) Rock salt (d) Zinc blende
74. Among the elements Zn, Ga, Ge as As, the one with the lowest first ionization energy is -
    (a) As (b) Zn (c) Ga (d) Ge
75. A binary fluoride (Z) of xenon combines with two moles of NaF to give a product which on hearting to 100°C affords compounds A. the alkaline hydrolysis of A gives perxenate salt. Z and A are, respectively,
    (a) XeF_2 and XeF_4 (b) XeF_4 and XeF_6
    (c) XeF_6 and XeF_4 (d) XeF_6 and XeF_6

76. Consider following statements:

I: $AsCl_5$ is thermally less stable than PCl_5.

II: Size of As is more than that of P.

choose correct answer from the following

(a) Statements I and II are true and II is the correct explanation of I.

(b) Statements I and II are true but II is not the correct explanation of I.

(c) Statement I is true and statement II is false.

(d) Both the statements I and II are false.

77. Consider the following statements for Be_2Cl_4 (I), B_2Cl_4 (II) and Ga_2Cl_4 (III):

(A) There is an M-M (M = Be, B, Ga) bond in all.

(B) The oxidation state of Be, B and Ga is +2.

(C) The geometry around the central atom is planar for all.

(D) The geometry around the central atom is planar in I and II only.

The correct statement(s) is/are

(a) A, B and C (b) A and B (c) D only (d) B. C and D

CSIR DEC 2018

78. The reaction of decaborane $B_{10}H_{14}$, with acetylene in the presence of Et_2S gives

(a) $C_2B_{10}H_{12}$ (b) $C_2B_8H_{10}$ (c) $C_2B_{10}H_{14}$ (d) $C_2B_9H_{11}$

79. In compound $N_3P_3F_6$, the geometry around nitrogen and phosphorus, respectively, are

(a) pyramidal and tetrahedral (b) planar and tetrahedral

(c) pyramidal and planar (d) planar and trigonal bipyramidal

80. The number of 2c-2e bonds ('x') of a molecule is related to 'N' (valence electrons) and 'n' (skeletal atoms) by x=(8n-N)/2. For P_4S_3 , the values of x , N and n, respectively, are

(a) 7, 38 ,9 (b) 7 , 24 , 9 (c) 9, 38, 7 (d) 9, 24, 7

81. B_2H_6 reacts with

(A) water to give boric acid and H_2 (B) oxygen to give B_2O_3 and H_2

(C) water to give boric acid and H_2O (D) oxygen to give B_2O_3 and H_2O

Correct statements from the above are

(a) A and B (b) A and D (c) B and C (d) B and D

82. Match the items given in Column-I with those given in Column-II

Column-I	Column-II
(A) Magic number	(I) Nuclear fission
(B) Liquid drop model of nucleus	(II) Q-value
(C) Actinides	(III) Radioactivity

(D) Threshold energy (IV) Shell model of nucleus

The correct match is

(a) A-IV, B-1, C-III, D-II (c) A-III, B-IV, C-I, D-II

(b) A-II, B-L, C-III, D-IV (d) A-IV, B-III, C-I, D-II

CSIR JUNE 2019

83. The species that results by replacing one quarter of Si(IV) in pyrophyllite [$Al_2(OH)_2\ Si_4O_{10}$] with Al(III) [charge balance by K(1)] is

(a) muscovile (b) phlogopite

(c) montmorillonite (d) talc

84. The oxidation state of sulphur in the dithionous and dithionic acids, respectively, are

(a) +4, +6 (b)-4, +5 (c) +3, +5 (d) +3, +6

85. In the synthesis of polydimethylsiloxane , the chain forming, branching and terminating agents respectively, are

(a) Me_2SiCl_2 , Me_3SiCl and $MeSiCl_3$

(b) Me_2SiCl_2, $MeSiCl_3$ and Me_3SiCl

(c) $MeSiCl_3$, Me_2SiCl_2 and Me_3SiCl

(d) Me_2SiCl_2 , $MeSiCl_3$ and Me_4Si

86. The correct statements regarding Boron among the following

(1) Nuclear spin of ^{11}B is greater than that of ^{10}B

(II) The polarities of B-H bond and C-H bonds are opposite

(III) Cross-section of neutron absorption for ^{10}B is much more than that of ^{11}B

(IV) B reacts with boiling aq. NaOH solution to form $NaB(OH)_4$

(a) II and III (b) I and II (c) III and IV (d) II and IV

87. Choose the correct statement(s) among the following

(I) LiF is more soluble than $LiClO_4$ in water.

(II) The standard reduction potential [E^0] of Li is more negative than that of Na

(III) The heat of hydration of $Li^+(g)$ is greater than that of $Na^+(g)$

(a) I and II (b) I and III (c) II and III (d) III Only

88. Choose the correct statement(s) among the following

(1) The dihedral angle in O_2F_2 is 0^0.

(II) OF_2 is generally prepared by reacting fluorine gas with dilute (2%) aq. NaOH solution

(III) O_2F_2 can be readily reduced by H_2S.

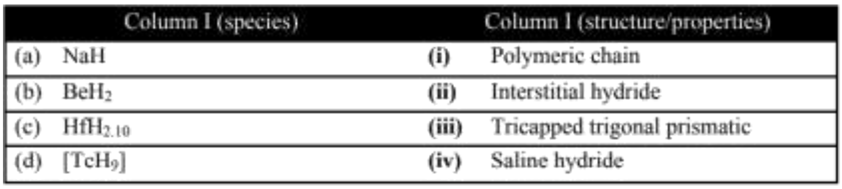
(a) I and II only (b) I, II and III (c) II and III only (d) II only

CSIR DEC 2019

89. The common heptacity observed for coordination of C_{60} to a metal center is

(1) 2 (2) 4 (3) 5 (4) 6

90. Match the items in Column I with those of Column II



Column I (species)		Column I (structure/properties)	
(a)	NaH	**(i)**	Polymeric chain
(b)	BeH_2	**(ii)**	Interstitial hydride
(c)	$HfH_{2.10}$	**(iii)**	Tricapped trigonal prismatic
(d)	$[TcH_9]$	**(iv)**	Saline hydride

The correct match is.

(a) a-iv, b-ii c-iii, d-i (b) a-i, b-iv, c-ii, d-iii

(c) a-iv, b-i, c-ii, d-iii (d) a-iv, b-i, c-iii, d-ii

91. Consider the following statements:

(A) The highest oxidation state of Group 3 elements is more readily shown in their oxides than in fluorides

(B) Fe can exist in-2 formal oxidation state also

(C) Mn , Tc and Re easily form M(II) compounds

The correct statement(s) is/are

(a) A and B (b) A and C (c) Band C (d) C only

92. The correct statements for dithionite and dithionate anions from the following are

(A) both have S-S bond

(B) both are dianionic

(C) oxidation state of sulphur is +3 and +5, respectively

(D) sulphur in dithionate has lone pair of electrons

(a) A, B and C (b) A, B and D (c) B, C and D (d) A and B only

CSIR - 2020

93. Correct statement/s among the following with respect to ionization energy (IE) is/are

(i) ($IE_1 + IE_2 + IE_3$) for indium is more than that of aluminium

(ii) IE_1 of scandium is higher than that of cobalt

(iii) IE_1 of gallium is lower than that of selenium

(iv) IE_1 of nitrogen is greater than that of oxygen

(a) (ii) and (iv) (b) (iii) and (iv)

(c) (i) and (iv) (d) (ii) and (iii)

94. The reason for significantly high solubility of $AgClO_4$ in benzene than in alkane solvents is

(a) Alkane solvents are non- polar. (b) Benzene is an aprotic solvent.

(c) PhAg is formed. (d)Benzene acts as a soft base

95. Choose the correct statements for the Group 15 halides:

(i)$AsCl_3$ can form complexes of type $[AsCl_4]^-$ in the presence of a chloride source

(ii) PF_3 acts as a strong a-donor ligand towards d-metals

(iii) In the solid state, SbF_5 has a trigonal bipyramidal structure

(iv) The reaction of SbF_5 with anhydrous HF generates $[H_2F]^+$ Ion

(a) (i) and (iv) (b) (ii) , (iii) and (iv) (c) (i) , (iii) and (iv) (d) (ii) and (iii)

96. The reaction of XeF_6 with a limited amount of quartz gives compound A. Then on reaction with an equivalent amount of XeO_3. A gives B. The products A and B are, respectively

(a) $XeOF_2$ and XeO_2F_2 (b) $XeOF_4$ and XeO_2F_2

(c) $XeOF_2$ and $XeOF_4$ (d) XeO_2F_2 and $XeOF_4$

97. The energies of interaction for (i) ion pair, (ii) ion-dipole, and (iii) dipole-dipole interactions are inversely proportional to

(a) r, r^2 and r^3 respectively (b) r^2, r and r^3 respectively

(c) r, r^2 and r^6 respectively (d) r^2, r and r^6 Respectively

CSIR JUNE 2021

98. The correct order of the electron affinity for one-electron gain of the elements is

(a) F > Cl > Br (b) P > N > As (c) S > Se > O (d) K > Li > Na

99. Which of the statements (A-D) given below are correct for B_2H_6 molecule:

A. Addition of $Et_2O.BF_3$ to $NaBH_4$ in a polyether solvent produces B_2H_6.

B. It has D_{2d} symmetry.

C. Reaction of B_2H_6 with NMe_3 give $Me_3N.BH_3$.

D. It is diamagnetic.

(a) A, B and C (b) A, C and D (c) A and B only (d) B and D only

100. Which of the following reaction (s) do(es) NOT occur

(i) $[NPCl_2]_3 + 6NaF \xrightarrow[\text{Reflux}]{\text{MeCN}} [NPF_2]_3 + 6NaCl$

(ii) $n\,PCl_5 + n\,NH_4Cl \xrightarrow[\text{Reflux}]{C_6H_5Cl} [NPCl_2]_n + 4\,nHCl$ [n=3,4,5....]

(iii) $n\,PF_5 + n\,NH_4F \xrightarrow[\text{Reflux}]{C_6H_5Cl} [NPF_2]_n + 4\,nHF$ [n=3,4,5....]

(a) (i) and (iii) (b) (i) and (ii) (c) (i) only (d) (iii) only

●●●●●●●

ANSWER KEY

MAIN GROUPS ELEMENTS

1.	(b)	2.	(a)	3.	(a)	4.	(a)	5.	(a)	6.	(a)	7.	(b)
8.	(b)	9.	(d)	10.	(a)	11.	(c)	12.	(c)	13.	(b)	14.	(a)
15.	(d)	16.	(c)	17.	(b)	18.	(a)	19.	(d)	20.	(d)	21.	(b)
22.	(b)	23.	(b)	24.	(d)	25.	(d)	26.	(a)	27.	(c)	28.	(c)
29.	(a)	30.	(b)	31.	(d)	32.	(c)	33.	(c)	34.	(d)	35.	(b)
36.	(a)	37.	(c)	38.	(c)	39.	(c)	40.	(a)	41.	(a)	42.	(d)
43.	(d)	44.	(a)	45.	(b)	46.	(c)	47.	(d)	48.	(c)	49.	(c)
50.	(a)	51.	(a)	52.	(a)	53.	(a)	54.	(d)	55.	(c)	56.	(a)
57.	(a)	58.	(b)	59.	(b)	60.	(a)	61.	(a)	62.	(a)	63.	(b)
64.	(c)	65.	(d)	66.	(a)	67.	(a)	68.	(d)	69.	(a)	70.	(c)
71.	(b)	72.	(c)	73.	(a)	74.	(c)	75.	(d)	76.	(b)	77.	(c)
78.	(a)	79.	(b)	80.	(c)	81.	(b)	82.	(a)	83.	(a)	84.	(c)
85.	(b)	86.	(a)	87.	(c)	88.	(c)	89.	(a)	90.	(c)	91.	(a)
92.	(a)	93.	(b)	94.	(d)	95.	(a)	96.	(b)	97.	(a)	98.	(c)
99.	(b)	100.	(d)										

4

Nuclear Chemistry

CSIRJUNE 2011

1. Consider the nuclear reaction

$_{92}X^{234} + \beta + \alpha \rightarrow Y + \gamma + 2\beta^+$

Y is

(a) $_{92}Y^{238}$ (b) $_{91}Y^{238}$ (c) $_{93}Y^{236}$ (d) $_{94}Y^{238}$

CSIR DEC 2019

2. Identify from following the products of K-electron capture by the nucleus:

(A). neutron (B). neutrino (C). positron

Answer is

(a) A only (b) A and B (c) C only (d) B and C

CSIR JUNE 2019

3. In neutron activation analysis the radiation commonly detected is

(a) α-rays (b) β-rays (c) γ-rays (d) X-rays

4. The set among the following in which all numbers are magic numbers of nucleons is

(a) 20, 28, 50 and 126 (b) 24, 28, 82 and 126

(c) 20, 50, 80 and 184 (d) 28, 50, 82 and 180

CSIR DEC 2017

5. Among the following nuclear reactions of thermal neutrons, the cross section is highest for:

(a) $_{92}U^{235} + _0n^1 \rightarrow _{92}U^{235} + _0n^1$ (b) $_{92}U^{235} + _0n^1 \rightarrow _{92}U^{236}$

(c) $_{92}U^{235} + _0n^1 \rightarrow _{90}Th^{232} + _2He^4$ (d) $_{92}U^{235} + _0n_1 \rightarrow _{36}K^{94} + _{56}Ba^{140} + 2_0n^1$

CSIR JUNE 2017

6. Which one of the following pairs has two magic numbers for closed nuclear shells?

(a) 8, 10 (b) 10, 20 (c) 50, 82 (d) 82, 130

7. Choose the correct statement for magnitude of threshold energy of an endoergic nuclear reaction between stationary nucleus and a moving projectile.

(a) It is greater than 'IQI' of nuclear reaction.

(b) It has to be more than kinetic energy of a projectile.

(c) It is less than 'IQI' of nuclear reaction.

(d) It has to be equal to kinetic energy of a projectile.

8. Consider following statements for fission of U^{235} with thermal neutrons.

A. The % of nuclei undergoing unsymmetrical fission is maximum.

B. In each fission, one thermal neutron is produced.

C. Magnitude of energy released per fission is of the order 200 MeV

Correct statement(s) is/are:

(a) A and B (b) B and C (c) A and C (d) C only

CSIR DEC 2015

9. Spin motion of which of the following gives magnetic moment

A. Electron; B. Proton; C. Neutron

Correct answer is:

(a) A and B (b) B and C (c) A and C (d) A, B and C

10. Identify radioactive capture from the following nuclear reactions:

(a)^{9}Be (γ, n) ^{8}Be (b)^{23}Na (n, γ) ^{24}Na

(c)^{63}Cu (p, p ^{3}n $^{9}\alpha$) ^{24}Na (d)^{107}Ag (n, n) ^{107}Ag

CSIR JUNE 2014

11. The nuclides among the following, capable of undergoing fission by thermal neutrons, are

(A) ^{233}U (B) ^{235}U (C) ^{239}Pu (D) ^{232}Th

(a) A, B and D (b) A, C and D (c) B, C and D (d) A, B and C

12. For a low energy nuclear reaction, ^{24}Mg (d, α) ^{22}Na, the correct statements from the following are

(a) Kinetic energy of d particle is not fully available for exciting ^{24}Mg.

(b) Total number of protons and neutrons is conserved

(c) Q value of nuclear reaction is much higher in magnitude relative to heat of chemical reaction

(d) Threshold energy is ≤ Q value.

13. The particles postulated to always accompany the positron emission among are:

(A) neutrino, (B) anti-neutrino, (C) electron,

(a) A, B and C (b) A and B (c) A and C (d) B and C

CSIR JUNE 2013

14. For neutron activation analysis of an element, the favourable characteristics of both the target and the product are from the following:

(A) high neutron cross-section area of target (B) long half-life of the product

(C) low neutron cross-section area of target (D) low half-life time of the product.

The correct characteristics from the above are

(a) 1 and 2 (b) 2 and 3 (c) 3 and 4 (d) 1 and 4

CSIR JUNE 2012

15. In ‘carbon-dating’ application of radioisotopes, 14 C emits

(a) β-particle (b) α-particle (c) γ-radiation (d) Positron.

CSIR DEC 2011

16. For the nuclear reactions.

(A) $^{8}_{4}\text{Be} \rightarrow 2\,^{4}_{2}\text{He}$ (B) $^{80}_{36}\text{Kr} \rightarrow 2\,^{40}_{18}\text{Ar}$

(Given masses: ^{8}Be = 8.005300, 4He=4.002603 and$^{80}_{36}Kr$ =79.81638,$^{40}_{18}$Ar= 39.96238)

The correct statement is:

(a) (A) and (B) are both spontaneous fission processes.

(b) (A) is spontaneous fission but (B) is not.

(c) (B) is spontaneous fission but (A) is not

(d) Both (A) and (B) are not spontaneous fission processes.

CSIR JUNE 2011

17. The species ^{19}Ne and ^{14}C emit a positron and β-particle respectively. The resulting species formed are respectively

(a) ^{19}Na and ^{14}B (b) ^{19}F and ^{14}N (c) ^{19}Na and ^{14}N (d) ^{19}F and ^{14}B

●●●●●●●

ANSWER KEY

NUCLEAR CHEMISTRY

1.	(b)	2.	(b)	3.	(c)	4.	(a)	5.	(d)	6.	(c)	7.	(a)
8.	(b)	9.	(d)	10.	(b)	11.	(d)	12.	(a)	13.	(c)	14.	(a)
15.	(a)	16.	(b)	17.	(b)								

5

Inorganic Spectroscopy

CSIRJUNE 2011

1. In the EPR spectrum of tetragonal Cu(II) complex, when $g_\parallel > g_\perp > g_e$, the unpaired electron resides in the orbital.

   (a) d_{xy} (b) $d_{x^2-y^2}$ (c) dz^2 (d) d_{xz}

2. Consider the compounds, (A) SnF_4 (B) $SnCl_4$ and (C) R_3SnCl. The nuclear quadrupole splitting are observed for.

   (a) (A), (B) and (C) (b) (A) and (B) only
   (c) (B) and (C) only (d) (A) and (C) only

3. The correct value of isomer shift (in Mossbauer spectra) and its explanation for Fe(II)-TPP and Fe(III)-TPP respectively from the following are: (TPP= tetraphenylporphyrinate)

   (A) 0.52 mms^{-1}
   (B) 0.45 mms^{-1}
   (C) Increase in s electron density
   (D) Decrease in s electron density.

   (a) (A) and (D); (B) and (C) (b) (A) and (C); (B) and (C)
   (c) (B) and (D); (A) and (D) (d) (B) and (D); (A) and (C)

CSIR DEC 2011

4. In the ^{19}F NMR spectrum of PF_5, the number of signals and multiplicity, at room temperature are

   (a) One, singlet (b) One, doublet (c) Two, doublet (d) Two, singlet

5. In 57Fe Mossbauer experiment, source of 14.4 keV (equivalent to 3.48×10^{12} MHz) is moved towards absorber at a velocity of 2.2 mms^{-1}.The shift in frequency of the source for this sample is:

(a) 35.5 MHz (b) 25.5 MHz

(c) 20.2 MHz (d) 15.5 MHz

CSIR JUNE 2012

6. If Mössbauer spectrum of $Fe(CO)_5$ is recorded in the presence of a magnetic field, the original spectrum with two lines changes into the one with

(a)Three lines (b) Four lines

(c) Five lines (d) Six lines

7. The metal complex that exhibits a triplet as well as doublet in its 31P NMR spectrum is

(a) mer-$[IrCl_3(PPh_3)_3]$ (b) trans-$[IrCI(Co)(PPh_3)_2]$

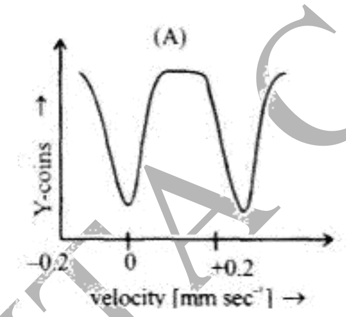
(c) fac-$[IrCl_3(PPh_3)_3]$ (d) $[Ir(PPh_3)_4]^+$

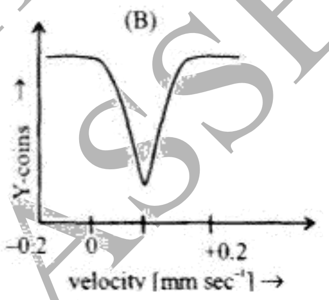
8. The total numbers of fine and hyperfine EPR lines expected for octahedral high-spin Mn(II) complexes are respectively (I= 5/2 for Mn)

(a) 3 and 30 (b) 5 and 33

(c) 5 and 30 (d) 4 and 24

9. The Mossbauer spectra of two iron complexes are shown below. They may arise from (i) highspin iron(III), (ii) high-spin iron(II) and (iii) low-spin iron(III)





CSIR DEC 2012

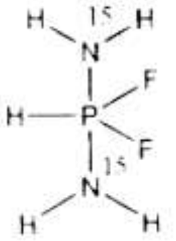
10. The number of lines exhibited by a high resolution EPR spectrum of the species, $[Cu(ethylenediamine)_2]^{2+}$ is [Nuclear spin (I) of Cu= 3/2 and that of N = 1]

(a) 12 (b) 15 (c) 20 (d) 36

11. The recoil energy of a Mossabauer nuclide of mass 139 amu is 2.5 MeV. The energy emitted by the nucleus in keV is:

(a) 12.5 (b) 15.0 (c) 20.5 (d) 25.0

12. Find out the number of lines in the ^{31}P NMR signal for diagram



(a) 3 (b) 6 (c) 18 (d) 90

CSIR JUNE 2013

13. The number of EPR signals observed for octahedral Ni (II) complexes is

(a) One (b) Two (c) Three (d) Zero

14. Among the following, those can act as Mössbauer muclei are

(A) ^{12}9I (B) ^{57}Co (C) ^{57}Fe (D) ^{121}Sb

(a) A, B, C and D (b) B, C and D only

(c) A, B, and D only (d) A, C and D only

15. For a tetragonally distorted Cr(III) complex, zero-field splitting results in the following number of Kramers doublets:

(a) 1 (b) 2 (c) 3 (d) 4

16. In the presence of an external magnetic field (normal Zeeman effect), the transition $^1D_2 \rightarrow {}^1P_1$ splits into

(a) 9 lines (b) 8 lines (c) 7 lines (d) 6 lines

17. In Mössbauer experiment, a source emitting at 14.4 KeV (3.48×10^{18} Hz) had to be moved towards absorber at 2.2 mms^{-1} for resonance. The shift in the frequency between the source and the absorber is

(a) 15.0 MHz (b) 20.0 MHz (c) 25.5 MHz (d) 30.0 MHz

CSIR JUNE 2014

18. The ^{19}F NMR spectrum of CIF_3 shows

(a) doublet and triplet for a T-shaped structure

(b) singlet for a trigonal planar structure

(c) singlet for a trigonal pyramidal structure

(d) doublet and singlet for a T-shaped structure

19. The low temperature (-98°C) ^{19}F NMR spectrum of SF_4, shows doublet of triplets with the point group symmetry.

(a) C_{3v} (b) C_{4v} (c) T_d (d) C_{2v}

20. The correct order of the isomeric shift in Mössbauer spectra (^{57}Fe source) of iron compounds is

(a) Fe(II) > Fe(III) > Fe(IV) (b) Fe(III) > Fe(II) > Fe(IV)

(c) Fe(IV) > Fe(III) Fe(II) (d) Fe(IV) >Fe(II) > Fe(III)

21. The number of lines in the ESR spectrum of CD_3 is (the spin of D is 1)

(a) 1 (b) 3 (c) 4 (d) 7

CSIR DEC 2014

22. EPR spectrum of a free radical containing nuclei with nonzero nuclear spin is obtained if the following selection rules are observed-

(a) $\Delta m_s = 0$, $\Delta m_l = 0$ (b) $\Delta m_s = \pm1$, $\Delta m_l = 0$

(c) $\Delta m_s = \pm1$, $\Delta m_l = \pm 1$ (d) $\Delta m_s = 0$, $\Delta m_l = \pm 1$

CSIR JUNE 2015

23. The 119Sn NMR chemical shift (approximately in ppm) corresponding to $(\eta^5\text{-Cp})_2$ Sn (relative to Me4Sn) is

(a) -4 (b) +137 (c) +346 (d) -2200

24. The reduced form of a metal ion M in a complex is NMR active. On oxidation, the complex gives an EPR signal with $g\| = 2.2$ and $g\perp = 2.0$. Mossbauer spectroscopy cannot characteristic the metal complex. The M is

(a) Zn (b) Sn (c) Cu (d) Fe

25. Mössbauer spectrum of a metal complex gives information about

(A) oxidation state and spin state of metal (B) types of ligands coordinated to metal

(C) nuclear spin state of metal (D) geometry of metal

Correct answer is

(a) A and C (b) B and C (c) A, B and D (d) B and D

CSIR JUNE 2016

26. Identify correct statements for the EPR spectrum of $VO(acac)_2$ [with one pyramidal geometry at vanadium] at 77 K [I(^{51}V) = 7/2]

(A) It has two g values (B) It has one g value

(C) It has 8 lines only (D) It has two patterns of 8 lines each.

Correct statements are –

(a) A and D (b) A and C (c) B and C (d) B and D

27. The numbers of lines shown by the BH_3 part of the molecule $Ph_3P.^{11}BH_3$ in the ^{1}H and ^{11}B NMR spectra are, respectively [I (^{11}B) = 3/2 ; I(^{31}P) = 1/2]

(a) 8 and 8 (b) 4 and 8 (c) 3 and 6 (d) 6 and 3

28. To record Mossbauer spectrum of Fe containing samples, a source 'X' is used. X after a nuclear transformation (Y), gives γ -radiation used in Mössbauer spectroscopy.

(a) ^{57}Fe, β-emission	(c) ^{57}Co, electron capture
(b) ^{57}Co, β-emission	(d) ^{57}Fe, electron capture

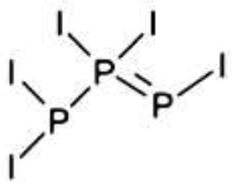
CSIR DEC 2016

29. The expected number of ^{19}F NMR spectral lines, including satellites, for $[XeF_5]^-$ is [Abundance of ^{129}Xe (I = 1/2) = 26%]

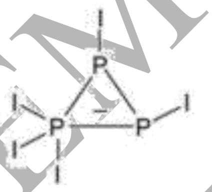
(a) two	(b) twenty one
(c) three	(d) one

30. The reaction between PI_3, $PSCl_3$ and zinc powder gives P_3I_5 as one of the products. The solution state 31P NMR spectrum of P_3I_5 shows a doublet (δ 98) and a triplet (δ 102). The correct structure of P_3I_5 is

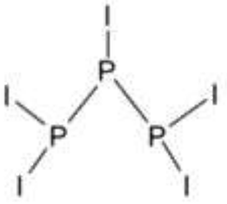
(a)



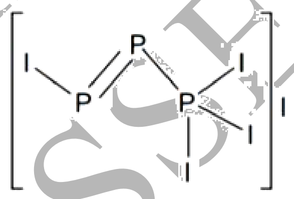
(b)



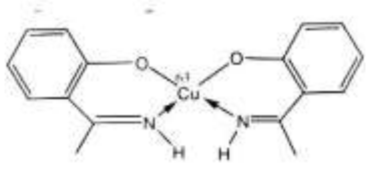
(c)



(d)

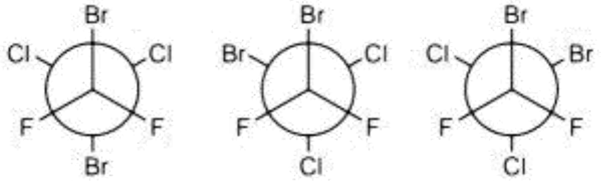


31. For complex A, deuteration of NH protons does not alter the EPR spectrum. The number of hyper fine lines expected in the EPR [I(^{63}Cu) = 3/2] spectrum of A is



(a) 20	(b) 12	(c) 60	(d) 36

32. Number of lines in the ^{19}F NMR spectrum of $F_2C(Br)$-$C(Br)Cl_2$, at -120°C assuming it a mixture of static conformations given below, are



(a) one (b) two (c) four (d) five

CSIR JUNE 2017

33. Mössbauer spectrum of complex [Fe(1, 10-phenanthroline)2(NCS)2] shows two lines at 300 K, four lines at 186 K, and again two lines at 77 K. This can be attributed to

A. change in the coordination mode of NCS

B. change in the spin-state of iron

C. cis-trans isomerisation

D. change in metal-ligand bond distances

The correct statements are

(a) A and B (b) B and C (c) A and C (d) B and D

34. $(R_3Ge)_2$ on photolysis gives a radical which shows ESR spectrum. The ESR signals carrying the signature of 73Ge (I = 9/2) are in terms of

(a) Nine lines (b) Ten lines (c) Two lines (d) One line

35. The ^{31}P(1H) NMR spectrum of 2,2,6,6-$N_4P_4Cl_4(NMe_2)_4$ is expected to show

(a) two triplets

(b) two doublets

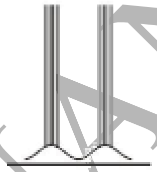
(c) one doublet and one triplet

(d) one quartet and one doublet

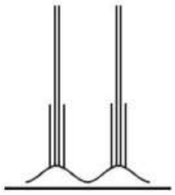
CSIR DEC 2017

36. Assuming $^1J_{PH} > J_{PB}$ the expected ^{31}P NMR spectrum of H_3P. $^{11}BCl_3$ [for ^{11}B, I = 3/2] is

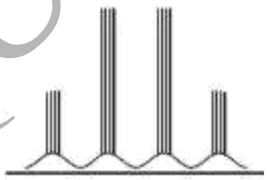
(a)



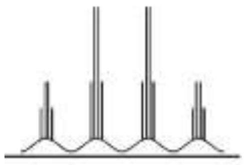
(b)



(c)



(d)



37. The number of lines in EPR spectrum of CD3 (ID = 1) is

(a) 3

(b) 5

(c) 7

(d) 9

CSIR DEC 2018

38. In the $^{31}P\{^1H\}$ NMR spectrum of a diamagnetic complex mer-$[M(PR_3)_3Cl_3]$ (M = transitionmetal, I = 0) expected number of resonance(s) is

(a) Three (b) One (c) Two (d) Six

39. The $^{31}P\{1H\}$ NMR spectrum of cis-$[Pt(PEt_3)_2Cl_2]$ (^{195}Pt (33.8% abundance) I = 1/2; its other isotopes are (NMR inactive: ^{31}P : I = 1/2) is comprised with satellite peaks of a

(a) triplet (b) singlet (c) doublet (d) quartet

40. Consider the following statements for $[FeO_4]^{-2}$

(A) It is stable in the pH range 0-14

(B) It is stable in strongly basic medium only

(C) It is a very strong oxidizing agent

(D) The isomer shift in its Mossbauer spectrum is more negative compared to that of $FeCl_3$.

The correct statements are

(a) A, C and D (b) B, C and D (c) B and C (d) C and D

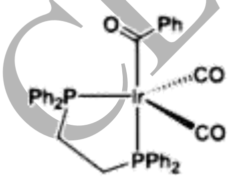
CSIR DEC 2019

41. For an a an octahedral Cu^{+2} complex depicting axial EPR spectrum (g), the geometry of Cu and the orbital containing the unpaired electron are respectively

(a) Tetragonally elongated, $d_{x^2-y^2}$ (b) Tetragonally compressed, d_{z^2}

(c) Tetragonally elongated, d_{z^2} (d) Tetragonally compressed, $d_{x^2-y^2}$

42. For the complex shown below in non-fluxional state, the expected $^{31}P\{^1H\}$ NMR resonance(s) is/are [$^{31}P = I = 1/2$]



(a) one singlet (b) one doublet (c) two Singlets (d) two doublets

43. In Mossbauer spectrum of a sample containing iron recorded in the presence of a static magnetic field, the number of possible allowed transition(s) is

(a) Two (b) Four (c) Six (d) Eight

•••••••

ANSWER KEY

INORGANIC SPECTROSCOPY

1.	(b)	2.	(c)	3.	(b)	4.	(b)	5.	(b)	6.	(d)	7.	(a)
8.	(c)	9.	(b)	10.	(d)	11.	(d)	12.	(d)	13.	(a)	14.	(d)
15.	(b)	16.	(a)	17.	(c)	18.	(a)	19.	(d)	20.	(a)	21.	(d)
22.	(b)	23.	(d)	24.	(c)	25.	(c)	26.	(a)	27.	(a)	28.	(c)
29.	(c)	30.	(c)	31.	(a)	32.	(d)	33.	(a)	34.	(b)	35.	(a)
36.	(c)	37.	(c)	38.	(c)	39.	(b)	40.	(b)	41.	(a)	42.	(d)
43.	(c)												

6

Lanthanides & Actinides

CSIRJUNE 2011

1. Among the following statements, identify the correct ones for complexes of lanthanide (III) ion.

(A) Metal-ligand bond is significantly ionic.

(B) Complexes rarely show isomerism.

(C) The coordination number is not more than 8.

(D) The magnetic moments are not accounted even approximately by spin only value for majority of lanthanides.

(a) A, B and D only (b) A, B and C only

(c) B and C only (d) A and D only

2. Statement I: The sizes of Zr and Hf are similar

Statement II: Size of Hf is affected by lanthanide contraction.

(a) Statement I and II are correct and II is correct explanation of 1.

(b) Statement I and II are correct but II is not a correct explanation of 1.

(c) Statement 1 is correct and II is incorrect

(d) Statements I and II both are incorrect.

3. The electronic configuration for gadalonium (Gd) is $[Xe]4f^7\ 5d^1 6s^2$, where as that of $Gd^{2+}$is:

(a) $[Xe]4f^5 5d6s^2$ (b) $[Xe]\ 4f^6\ 6s^2$ (c) $[Xe]f6\ 5d^1\ 6s^1$ (d) $[Xe]4f^7\ 5d^1$

4. Uranium fluorides co-precipitate with

(a) CaF_2 (b) AgF (c) LiF (d) MgF_2

CSIR DEC 2011

5. The actual magnetic moment shows a large deviation from the spin-only formula in the case of

(a) Ti^{1+} (b) V^{3+} (c) Gd^{3+} (d) Sm^{3+}

CSIR JUNE 2012

6. The least basic among the following is:

(a) $Al(OH)_3$ (b) $La(OH)_3$ (c) $Ce(OH)_3$ (d) $Lu(OH)_3$

7. The pair of lanthanides with the highest third-ionization energy is:

(a) Eu, Gd (b) Eu, Yb (c) Dy, Yb (d) Lu, Yb

8. The lanthanide(III) ion having the highest partition coefficient between tri-n-butylphosphate and concentrated HNO_3 is:

(a) La(III) (b) Eu(III) (c) Nd(III) (d) Lu(III)

CSIR DEC 2012

9. Which one of the following shows the highest solubility in hot concentrated aqueous NaOH?
(a) $La(OH)_3$ (b) $Nd(OH)_3$ (c) $Sm(OH)_3$ (d) $Lu(OH)_3$.

10. Consider the ions Eu(III), Gd(III), Sm(II) and Lu(III). The observed and calculated magnetic moment values are closest for the pair

(a) Gd(III), Lu(III) (b) Eu(III), Lu(III) (c) Sm(III), Gd(III) (d) Sm(III), Eu(III)

CSIR JUNE 2013

11. Consider following lanthanide (III) ions

(A) Nd(III) (B) Gd(III) (C) Dy(III)

The magnetic moment closest to the spin only value is(are) for

(a) B only (b) A and B only (c) A and C only (d) B and C only

12. The ground state term symbol for Nb(atomic number 41) is ^6D. The electronic configuration corresponding to this term symbol is

(a) $[Kr]4d^3\,5s^2$ (b) $[Kr]4d^4\,5s^1$ (c) $[Kr]4d^5\,5s^0$ (d) $[Kr]4d^3\,5s^1\,5p^1$

CSIR DEC 2013

13. The ground state forms of Sm and Eu respectively, are

(a) $^7F_0$ and $^6H_{5/2}$ (b) $^6H_{5/2}$ and $^7F_0$ (c) $^2F_{5/2}$ and $^5I_4$ (d) $^7F_6$ and $^2F_{7/2}$

CSIR JUNE 2014

14. A comparison of the valence electron configuration of the elements, Sm and Eu suggests that

(a) Sm is a better one electron reductant than Eu

(b) Sm is a better one electron oxidant than Eu

(c) Facile oxidation state is +2 for both the elements

(d) both of these display similar redox behaviour

CSIR DEC 2014

15. The correct order of the retention of cations on a sulfonated cation exchange resin column is

(a) $Ag^+ > K^+ > Na^+ > Li^+$ (b) $K^+ > Na^+ > Ag^+ > Li^+$

(c) $Li^+ > Na^+ > K^+ > Ag^+$ (d) $Li^+ > Na^+ > Ag^+ > K^+$

16. Hindered ß-diketonates like dpmH (dpmH = dipivaloylmethane) are used for the separation of lanthanides because complexes formed with dpmH can be separated by

(a) Gel permeation chromatography (b) Gas chromatography

(c) Gel filtration chromatography (d) Ion exchange chromatography

CSIR JUNE 2015

17. Consider the following statements with respect to uranium

(A) UO_2^+disproportionates more easily than UO_2^{+2}

(B) U_3O_8 is its most stable oxide of U

(C) Coordination number of U in $[UO_2(NO_3)_2(H_2O)_2]._4H,O$ is six.

(D) UO_2^{+2} is linearThe correct set of statements is

(a) A, B and D (b) A, C and D (c) B, C and D (d) A, B and C

18. Consider the following statements for $(NH_4)_2[Ce(NO_3)_6](Z)$

(A) Coordination number of Ce is 12

(B) Z is paramagnetic

(C) Z is an oxidising agent

(D) Reaction of Ph_3PO with Z gives a complex having coordination number 10 for Ce.

The correct statements are

(a) A, B and C (b) B, A and D (c) B, C and D (d) A, C and D

CSIR DEC 2015

19. The metallic radii are abnormally high for which of the following pairs?

(a) Eu, Yb (b) Sm, Tm (c) Gd, Lu (d) Nd, Ho

20. Which of the following statements are TRUE for the lanthanides?

(A) the observed magnetic moment of Eu at room temperature is higher than that calculated from spin-orbit coupling

(B) Lanthanide oxides are predominantly acidic in nature

(C) The stability of Sm(II) is due to its half-filled sub-shell.

(D) Lanthanide (III) ions can be separated by ion exchange chromatography

Correct answer is

(a) A and D (b) A and B (c) A and C (d) B and C

CSIR JUNE 2016

21. For monoionic complex $[UO_2(NO_3)_3\ ]^{-1}$ the correct coordination number and geometry respectively, are

(a) 8 and hexagonal bipyramedal (b) 5 and square pyramidal

(c) 8 and square antiprism (d) 5 and trigonal bipyramidal

22. The g values for Ce^{+3} $(4f^1)$ and Pr^{+3} $(4f^2)$ are, respectively

(a) 3/7 and 2/5 (b) 5/7 and 4/5 (c) 6/7 and 3/5 (d) 6/7 and 4/5

CSIR JUNE 2017

23. Which one of the following pairs has two magic numbers for closed nuclear shells ?

(a) 8, 10 (b) 10, 20 (c) 50, 82 (d) 82, 130

24. The calculated and observed magnetic moments (in B.M.) of aqua complex of a lanthanide ion are 0 and ~3.5, respectively. The lanthanide ion is

(a) Pm^{+3} (b) Pr^{+3} (c) Eu^{+3} (d) Sm^{+3}

CSIR DEC 2017

25. Match lanthanides in Column I with their properties in Column II

Column I Column II
A. Lu (i) Reagent in oxidation state IV
B. Eu (ii) Ml, of metallic lustre
C. Ce(iii) DiamagenticM(III)
D. Tb (iv) Pink in oxidation state III

Correct match is

(a) A-(iii), B-(ii); C-(i); D-(iv) (c) A-(iv), B-(ii); C-(i); D-(iii)

(b) A-(ii), B-(iii); C-(iv); D-(i) (d) A-(iii), B-(ii): C-(iv); D-(i)

26. Consider the following statement(s) for actinides (An):

A. Oxidation states greater than +3 are more frequent in An compared to lathanides (Ln)

B. Some An(III) ions show d-d transitions

C. UO_2^{+2} and PuO_{2+2} are stable

D. Some of actinides do not have radioactive isotopes

The correct answer is

(a) A and C (b) Band D (c) A, B and C (d) B, C and D

CSIR JUNE 2018

27. Trivalent lanthanide ion having isotropic magnetic susceptibility is

(a) Eu^{+3} (b) Gd^{+3} (c) Yb^{+3} (d) Lu^{+3}

28. Match fluorescence colours given in column A with lanthanide ions given in Column B

Column A	Column B
(i) Pink	(a) Sm(III)
(ii) Red	(b) Tb(III)
(iii) Green	(c) Eu(III)
(iv) Blue	(d) Tm(III)

Correct match is

(a) (i)-(a); (ii) - (c); (iii)-(b); (iv) - (d) (b) (i)-(d); (ii)-(c); (iii)-(b); (iv) - (a)

(c) (i)-(a); (ii)-(b); (iii) - (c); (iv)-(d) (d) (i)-(c); (ii)-(b); (iii)- (d); (iv)-(a)

CSIR DEC 2018

29. Consider following statements for Eu^{+3}

(A) The positions of sharp bands in UV-vis spectra of its complexes depend heavily on the ligand environment

(B) Its ground state term symbol is $^7F_0$

(C) The observed magnetic moment is due to populated higher level

(D) At 2K its magnetic moment approaches to zero

The set of correct statements is

(a) A, C and D (b) B, C and D (c) A, B and D (d) A, B and C

CSIR JUNE 2019

30. The coordination number of Gd in $GdCl_3.6H_2O$ is

(a) 3 (b) 6 (c) 8 (d) 9

CSIR DEC 2019

31. Pair of lanthanide ions which show significant deviation between the experimental and calculated magnetic moments, considering contribution from the ground state only

(a)Gd and Lu (b) Sm and Th (c)Eu and Tb (d)Sm and Eu

CSIR 2020

32. The pair in which both actinides show +3 oxidation state only is

(a) Ac and Lr (b)Ac and No (c) Cm and Bk (d) Cm and Lr

33. The correct match for column A with column B is :

Column A	**Column B**
(a) f→f transition	(i) Tb^{3+}
(b)$^5D_0 \rightarrow {}^7F_n$ emission	(ii) Lu^{3+}
(c)$^5D_4 \rightarrow {}^7F_n$ emission	(iii) Sm^{3+}
(d)Overlapping J levels	(iv) Eu^{3+}

(a) (a) - (iv) , (b) - (i) , (c)-(ii), (d) - (iii)
(b)(a) - (ii), (b) - (iv) , (c) - (iii), (d) - (i)
(c)(a) - (ii) , (b)-(iv) , (c)-(i) , (d)-(iii)
(d)(a)- (i) , (b)- (iii) , (c)-(ii) , (d) - (iv)

CSIR JUNE 2021

34. The effective magnetic moment (in BM) for a lanthanide f^{10} ion is approximately

(a) 10.6 (b) 9.92 (c) 9.59 (d) 7.94

•••••••

ANSWER KEY

LANTHANIDES AND ACTINIDES

1.	(a)	2.	(a)	3.	(d)	4.	(a)	5.	(d)	6.	(a)	7.	(b)
8.	(d)	9.	(d)	10.	(a)	11.	(a)	12.	(b)	13.	(b)	14.	(b)
15.	(a)	16.	(b)	17.	(a)	18.	(d)	19.	(a)	20.	(a)	21.	(a)
22.	(d)	23.	(c)	24.	(c)	25.	(a)	26.	(a)	27.	(b)	28.	(a)
29.	(b)	30.	(c)	31.	(d)	32.	(a)	33.	(c)	34.	(a)		

7

Chemical Bonding

CSIRJUNE 2011

1. Among SF_4^-, BF_4^-, XeF_4, and ICI_4^-, the number of species having two lone pair of electrons central atom according to VSEPR theory is:
(a) 2 (b) 3 (c) 4 (d) 0

2. In the molecules H_2O, NH_4 and CH_4
(a) The bond angles are same (b) The bond distances are same
(c) The hybridizations are same (d) The shapes are same

3. According to VSEPR theory, the molecule/ion having ideal tetrahedral shape is
(a) SF_4 (b) SO_4^{-2} (c) S_2Cl_2 (d) SO_2Cl_2

4. The highest occupied MO in N_2 and O_2^+ respectively are (take x-axis as internuclear axis)
(a) $\sigma_{2px}, \pi^*_{2py}$ (b) π_{2py}, π_{2pz} (c) $\sigma^*_{2py}, \sigma_{2px}$ (d) π^*_{2py}, π^*_{2pz}

5. The molecule with highest number of lone-pairs and has a linear shape based on VSEPR theory is:
(a) CO_2 (b) Γ_3 (c) NO_2^- (d) NO_2^+

6. The number of anti-bonding electrons in NO and CO according to MO theory are respectively.
(a) 1,0 (b) 2,2 (c) 3,2 (d) 2,3

7. Among the following pairs, those in which both species have similar structures are:
(A) N_3^-, XeF_2 (B) $[ICl_4]^-, [PtCl_4]^{2-}$ (C) $[ClF_2]^+ [ICl_2]^-$ (D) XeO_3, SO_3
(a) (A) and (B) only (b) (A) and (C) only
(c) (A), (B) and (C) only (d) (d) (B), (C) and (D) only

8. Match list I (compounds) with list II (structures), and select the correct answer using the codes given below.

	List – I		List- II
(a)	XeO_4	(I)	Square planar
(b)	BrF_4^-	(ii)	Tetrahedral
(c)	$SeCl_4$	(iii)	Distorted tetrahedral

(a) (A-ii) (B-iii) (C-i) (b) (A- iii) (B-i) (C-ii)
(c) (A-ii) (B-i) (C-iii) (d) (A-i) (B-ii) (C-iii)

CSIR JUNE 2012

9. The size of the d orbitals in Si, P, S and Cl follows the order.

(a) Cl > S > P > Si (b) Cl > P > S > Si

(c) P > S > Si >Cl (d) Si > P > S >Cl

10, The total number of lone pairs of electrons in I_3^- is:

(a) Zero (b) Three (c) Six (d) Nine

11. The strength of $P\pi - d\pi$ bonding in E-O (E = Si, P, S and Cl) follows the order

(a) Si-O > P-O > S-O > Cl-O (b) P-O > Si-O > S-O > Cl-O

(c) S-O > C1-O > P-O > Si-O (d) Cl-O > S-O > P-O > Si-O

12. The decreasing order of dipole moment of molecules is

(a) $NF_3 > NH_3 > H_2O$ (b) $NH_3 > NF_3 > H_3O$

(c) $H_2O > NH_3 > NF_3$ (d) $H_2O > NF_3 > NH_3$

CSIR DEC 2012

13. Which ones among CO_3^{-2}, SO_3, XeO_3 and NO_3^{-1}, have planar structure?

(a) CO_3^{-2}, SO_3 and XeO_3 (b) SO_3, XeO_3 and NO_3^-

(c) CO_3^{-2}, XeO_3 and NO_3^- (d) CO_3^{-2}, SO_3 and NO_3^-

14. When a hydrogen a is placed in an electric field along the y-axis, the orbital that mixes most with the ground state 1s orbital is

(a) 2s (b) $2p_x$ (c) $2p_y$ (d) $2p_z$

CSIR JUNE 2013

15. Among the compounds A-D, those which hydrolyse easily are

(a) NCl_3 (b) NF_3 (c) $BiCl_3$ (d) PCl_3

16. The number of lone-pairs are identical in the pairs

(a) XeF_4, ClF_3 (b) XeO_4, ICl_4^- (c) XeO_2F_2, ICl_4^- (d) XeO_4, ClF_3

17. Among the following, an example of a hypervalent species is

(a) $BF_3.OEt_2$ (b) SF_4 (c) $[PF_6]^-$ (d) Sb_2S_3

18. The molecule in which the bond order increases upon addition of an electron

(a) O_2 (b) B_2 (c) P_2 (d) N_2

19. The energy of 2s and 2p orbitals is the same for

(a) Li (b) Li^{+2} (c) Be^{+2} (d) H^{-}

20. If a homonuclear diatomic molecule is oriented along the Z-axis, the molecular orbital formed by linear combination of px, orbitals of the two atoms is

(a) σ (b) σ^* (c) π (d) δ

21. According to VSEPR theory, the geometry (with lone pair) around the central iodine in I_3^+ and I_3^- ions respectively are

(a) tetrahedral and tetrahedral

(b) trigonal bipyramidal and trigonal bipyramedal

(c) tetrahedral and trigonal bipyramidal

(d) tetrahedral and octahedral

CSIR JUNE 2014

22. The correct non-linear and iso-structural pair is

(a) SCl_2 and I_3^- (b) SCl_2, and I_3^+ (c) SCl_2, and ClF_2^- (d) I_3^+ and ClF_2

23. Structures of $SbPh_5$ and PPh_5 respectively are

(a) trigonal bipyramidal, square pyramidal

(b) square pyramidal, trigonal bipyramidal

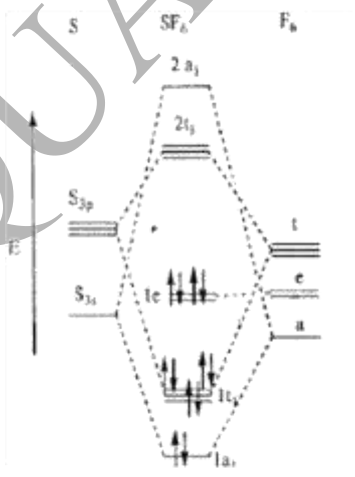
(c) trigonal bipyramidal, trigonal bipyramidal

(d) square pyramidal, square pyramidal

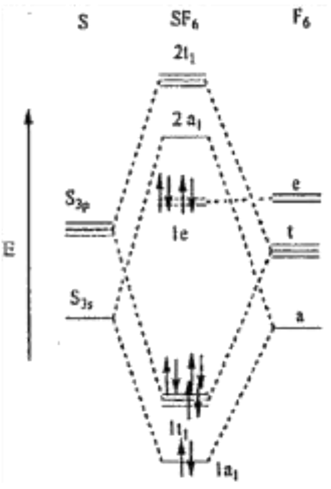
24. The maximum bond order obtained from the molecular orbitals of a transition metal dimer, formed as linear combinations of d-orbitals alone, is

(a) 3 (b) 4 (c) 5 (d) 6

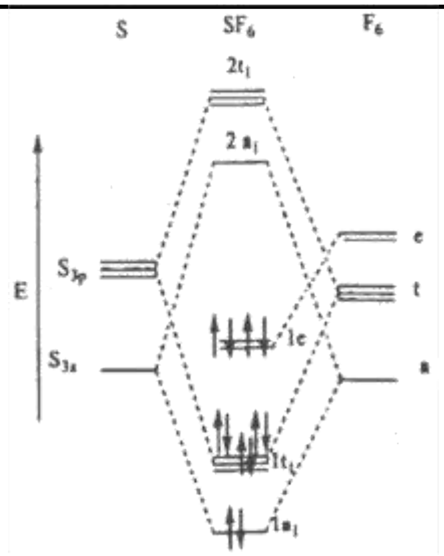
25. The correct schematic molecular energy diagram for SF_6 molecule is:



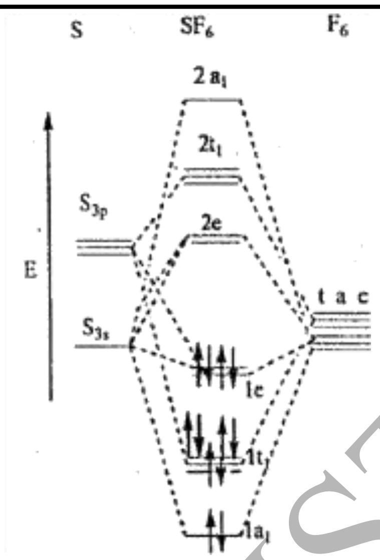
(a)



(b)



(c)



(d)

CSIR DEC 2014

26. The δ-bond is formed via the overlap of

(a) $d_{x^2-y^2}$ and $d_{x^2-y^2}$ orbitals (b) d_{xz} and d_{xz} orbitals

(c) d_{xy} and d_{xy} orbitals (d) d_{yz} and d_{yz} orbitals

27. For the oxidation state(s) of Sulphur atoms in S_2O, consider the following

A. -2 and +4 B. 0 and +2 C. +4 and 0

The correct answer(s) is/(are)

(a) A and B (b) A and C (c) B and C (d) C only

CSIR JUNE 2015

28. The geometries of $[Br_3]^+$ and $[I_5]^+$ respectively, are

(a) trigonal and tetrahedral (b) tetrahedral and trigonal bipyramidal

(c) tetrahedral and tetrahedral (d) linear and trigonal pyramidal

CSIR DEC 2015

29. The structures of XeF_2 and XeO_2F_2 respectively are

(a) bent, tetrahedral (b) linear, square planar

(c) linear, see-saw (d) bent, see-saw

30. The molecule C_3O_2 has a linear structure. This compound has

(a) 4σ and 4π bonds. (b) 3σ and 2π bonds

(c) 2π and 3π bonds (d) 3σ and 4π bonds

31. Among the following, species expected to show fluxional behaviour are

(A) $[NiCl_4]^{-2}$ (tetrahedral) (B) IF_7 (pentagonal bipyramidal)

(C) $[CoF_6]^{-3}$ (octahedral) (D) $Fe(CO)_5$ (trigonal bipyramidal)

(a) B and C (b) B and D (c) C and D (d) A and D

32. The correct statement among the following is

(a) N_2 has higher bond order than N_2^+ and hence has larger bond length compared to

(b) has higher bond order than N_2 and hence has larger bond length compared to N_2

(c) N_2 has higher bond order than N_2^+ and hence has higher dissociation energy compared to

(d) N_2 has lower bond order than N_2^+ and hence has lower dissociation energy compared to energy

33. The number of lone pair(s) of electrons on the central atom in $[BrF_4]^-$, XeF_6 and $[SbCl_6]^-$ are respectively

(a) 2, 0 and 1 (b) 1, 0 and 0 (c) 2, 1 and 1 (d) 2, 1 and 0

34. The ground state electronic configuration of C_2, using all electron is

(a) $\sigma_{1s}^2\sigma^{*2}_{1s}\,\sigma_{2s}^2\sigma^{*2}_{2s}\,\sigma_{2p}^2\pi_{2p}^2$ (b) $\sigma_{1s}^2\sigma^{*2}_{1s}\,\sigma_{2s}^2\sigma^{*2}_{2s}\,\sigma_{2p}^2\pi^{*2}_{2p}$

(c) $\sigma_{1s}^2\sigma^{*2}_{1s}\,\sigma_{2s}^2\sigma^{*2}_{2s}\,\pi_{2p}^2\sigma_{2p}^1\sigma^{*1}_{2p}$ (d) $\sigma_{1s}^2\sigma^{*2}_{1s}\,\sigma_{2s}^2\sigma^{*2}_{2s}\,\pi_{2p}^4$

CSIR JUNE 2016

35. Correct combination for π and π^* orbitals in B_2 molecule is

π	π^*
(a) Gerade	Ungerade
(b) Ungerade	Gerade
(c) Gerade	Gerade
(d) Ungerade	Ungerade

36. The correct shape of $[TeF_5]^{-1}$ ion on the basis of VSEPR theory is

(a) Trigonal bipyramidal

(b) Square pyramidal

(c) Pentagonal planar

(d) See-saw

37. The number of 3c-2e bonds present in $Al(BH_4)_3$ is-

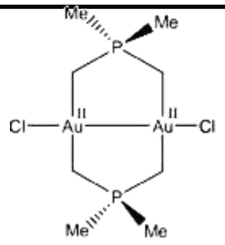
(a) four (b) three (c) six (d) zero

38. The expected H-H-H bond angle in $[H_3]^+$ is

(a) 180° (b) 120°

(c) 60° (d) 90°

39. The oxidation state of gold in the following complex is



(a) 0 (b) 1 (c) 2 (d) 3

40. The numbers of triangular faces in square antiprism, icosahedron and tricapped trigonal prism (capped on square faces), respectively, are

(a) 8, 20 and 14 (b) 8, 20 and 12

(c)10,12 and 14 (d) 10, 12 and 12

CSIR JUNE 2017

41. Based on VSEPR theory, the predicted shapes of $[XeF_5]^-$ and BrF_5 respectively, are

(a) pentagonal planar and square pyramidal

(b) square pyramidal and trigonal bipyramidal

(c) trigonal bipyramidal and square pyramidal

(d) square pyramidal and pentagonal planar

CSIR DEC 2017

42. Among ClO_3, XeO_3 and SO_3, species with pyramidal shape is/are?

(a) and XeO_3 (b) XeO_3 and SO_3

(c) and SO_3 (d) SO_3

43. Geometries of SNF_3 and XeF_2O_2 respectively, are

(a) square planar and square planar

(b) square planar and trigonal bipyramidal

(c) tetrahedral and trigonal bipyramidal

(d) tetrahedral and tetrahedral

44. According to Bent's rule, for p-block elements, the correct combination of geometry around the central atom and position of more electro-negative substituent is

(a) Trigonal bipyramidal and axial (b) Triogonal bipyramidal and equatorial

(c) Square pyramidal and axial (d) Square pyramidal and basal

45. Allred-Rochow electronegativity of an element is

A. directly proportional to the effective nuclear charge

B. directly proportional to the covalent radius

C. inversely proportional to the square of the covalent radius

D. directly proportional to the square of the effective nuclear charge

The correct answer is

(a) A and B (b) A and C (c) B and C (d) A and D

CSIR JUNE 2018

46. Dinuclear anion $[I_2(OH)_2O_8]^{-4}$ has two bridging oxo groups. The geometry around each iodine is

(a) Octahedral (b) Monocapped octahedral

(c) Square pyamidal (d) Pentagonal bipyramedal

47. Removal of an electron form NO molecule results in

A. An increase in the (NO) in the IR spectrum

B. An EPR active species

C. Electrons in HOMOs being closer to the oxygen than to nitrogen 2p orbital's

D. Electrons in HOMOs being closer to the nitrogen than to oxygen 2p orbital's

The correct answer is

(a) A only (b) A and C (c) Band D (d) A. B, and C

48. Consider the nature of solvents in column I and the corresponding max for l in various solvents given in column II. (for I, vapor axis 520 nm). Match column I with column II

	Column – I		Column – II
(a)	Non-donor	(i)	520
(b)	Weak donor	(ii)	500
(c)	Strong donor	(iii)	450
(d)	π electron donor	(iv)	360

(a) (a)-(i); (b)-(ii); (c)-(iii); (d)- (iv) (b) (a)-(iii); (b)-(iv); (c)-(ii); (d)-(i)

(c) (a)-(i); (b)-(iii); (c)-(iv); (d)- (ii) (d) (a)-(iv); (b)-(iii); (c)-(ii); (d)-(i)

49. Identify the correct statements about the electro negativity of groups given below:

(A) CF_3 group has greater value than that of NF_2

(B) NH_2 group has lower value than that of NF_2

(C) OH group has greater value than that of NF_2

(D) CH_3 and C_2H_5 groups have almost similar values

Correct answer is

(a) A. B and D (b) B and C

(c) B, C and D (d) B and D

CSIR DEC 2018

50. Among $SiCl_4$, $P(O)Cl_3$, NF_3, trans-$[SnCl_4(py)_2]$ (py-pyridine), those with zero dipole moment are

(a) $SiCl_4$, and NF_3

(c) $SiCl_4$, and trans-$SnCl_4(py)_2$

(b) $SiCl_4$, $P(O)Cl_3$, and trans-$SnCl_4(py)_4$

(d) NF_3 and trans-$SnCl_4(py)_2$

51. The characters of LUMO and CN^- and O_2 respectively, are

(a) σ_g and π_u (b) π and σ_u (c) π_g and σ_u (d) σ_u and π_g

52. Arrange the following molecules in order of increasing fundamental vibrational frequencies

(a) $O_2^{-2} < O_2^- < O_2 < O_2^+$

(b) $O_2 < O_2^+ < O_2^- < O_2^{-2}$

(c) $O_2^{-2} < O_2^- < O_2^+ < O_2$

(d) $O_2^+ < O_2 < O_2^- < O_2^{+2}$

CSIR JUNE 2019

53. O_2^- is

(a) having a shorter O-O bond length than that in O_2

(b) a stronger oxidising agent than O_2

(c) IR active

(d) unable to abstract proton from weak acids

54. Among the following, the correct statement about π-molecular orbitals (π-MOs) of benzene is

(a) Only the lowest energy MO is doubly degenerate

(b) Only LUMO is doubly degenerate

(c) Only HOMO is doubly degenerate

(d) Both the HOMO and LUMO are doubly degenerate

55. Match the appropriate geometry on the right with each of the speices on the left

(A) $FXeO(OSO_2F)$	(I) linear
(B) $FXeN(SO_2F)_2$	(II) pyramidal
(C) XeO_3	(III) T-shaped
(D) $XeOF_2$	(IV) bent

(a) A-I, B-I, C-II, D-III

(b) A-I, B-1. C-II, D-IV

(c) A-IV, B-I, C-II, D-III

(d) A-1, B-IV, C-II, D-III

CSIR DEC 2019

56. The ion having the highest bond order is

(a) NO^+ (b) O_2^+ (c) N_2^+ (d) C_2^+

57. The magnitude of bond angles in gaseous NF_3 , SbF_3 and $SbCl_3$ follow the order

(a) $NF_3 > SbF_3 > SbCl_3$ (b) $SbCl_3 > SbF_3 > NF_3$

(c) $SbF_3 > SbCl_3 > NF_3$ (d) $NF_3 > SbCl_3 > SbF_3$

58. The species for which the shapes (geometry) can be predicted by VSEPR theory is/are

(A) $[PtCl_4]^{2-}$ (B) $[TeCl_6]^{2-}$ (C) PF_3 and SF_6

(a) A and C (b) B and C (c) C only (d) A and B

CSIR 2020

59. Choose the correct order of energy of $2\sigma_g$ and $1\pi_0$ molecular orbitals for B_2 , C_2 and O_2 :

(a) $2\sigma_g > 1\pi_u$ for all the three

(b) $2\sigma_g > 1\pi_u$ for B_2 and C_2 only

(c) $1\pi_u > 2\sigma_g$ for C_2 and O_2 only

(d) $2\sigma_g > 1\pi_u$ for B_2 and O_2 only

60. As per the VSEPR theory, shapes of and are, respectively

(a) Trigonal pyramidal, trigonal planar and tetrahedral

(b) trigonal planar, trigonal pyramidal and square planar

(c) trigonal pyramidal, trigonal planar and square planar

(d) trigonal planar, trigonal pyramidal and tetrahedral

61. Consider the following statements for Allred-Rochow electronegativity (AR):

(i) AR is directly proportional to Z_{eff}

(ii) AR is inversely proportional to Z_{eff}

(iii) AR is inversely proportional to r(covalent)

(iv) AR is inversely proportional to r^2 (covalent)

The correct statements are

(a) (i) and (iv) (b) (ii) and (iv) (c) (i) and (iii) (d) (ii) and (iii)

62. The total bond order between adjacent carbon atoms of benzene is

(a) 0.5 (b) 2 (c) 1.5 (d) 2.5

CSIR JUNE 2021

63. Among the following which set of molecular/ionic species all have a planar structure?

(a) $BrF_3, FClO_2$ and $[XeF_5]^-$ (b) $XeO_3, [ClF_4]^-$ and $FClO_2$

(c) $[ClF_4]^-, BrF_3$ and $[XeF_5]^-$ (d) $FClO_2, [XeF_5]^-$ and XeO_3

64. The total number of lone pairs of electrons on all the atoms in cyanogen azide and thiocyanogen respectively, are

(a) 4 and 6 (b) 6 and 6 (c) 3 and 4 (d) 4 and 4

65. For $[Hg_2]^{2+}$, the bond order and the orbitals involved in bonding are, respectively

(a) one; s and s (b) two; s and p (c) one; p and p (d) three; s and d

•••••••

ANSWER KEY

CHEMICAL BONDING

1.	(b)	2.	(c)	3.	(b)	4.	(a)	5.	(b)	6.	(a)	7.	(b)
8.	(c)	9.	(d)	10.	(d)	11.	(d)	12.	(d)	13.	(d)	14.	(c)
15.	(d)	16.	(a)	17.	(c)	18.	(b)	19.	(b)	20.	(c)	21.	(c)
22.	(b)	23.	(b)	24.	(c)	25.	(a)	26.	(a,c)	27.	(a)	28.	(b)
29.	(c)	30.	(a)	31.	(b)	32.	(c)	33.	(c)	34.	(d)	35.	(b)
36.	(b)	37.	(c)	38.	(c)	39.	(c)	40.	(a)	41.	(a)	42.	(a)
43.	(d)	44.	(a)	45.	(b)	46.	(a)	47.	(b)	48.	(c)	49.	(d)
50.	(c)	51.	(c)	52.	(a)	53.	(b)	54.	(d)	55.	(a)	56.	(a)
57.	(d)	58.	(c)	59.	(b)	60.	(c)	61.	(a)	62.	(c)	63.	(c)
64.	(a)	65.	(a)										

8

Acids & Bases

CSIRJUNE 2011

1. The correct order of acidity among the following species is

(a) $[Na(H_2O)_6]^+ > [Ni(H_2O)_6]^{+2} > [Mn(H_2O)_6]^{+2} > [Sc(H_2O)_6]^{+3}$

(b) $[Sc(H_2O)_6]^{+3} > [Ni(H_2O)_6]^{+2} > [Mn(H_2O)_6]^{+2} > [Na(H_2O)_6]^+$

(c) $[Mn(H_2O)_6]^{+2} > [Ni(H_2O)_6]^{+2} > [Sc(H_2O)_6]^{+3} > [Na(H_2O)_6]^+$

(d) $[Sc(H_2O)_6]^{+3} > [Na(H_2O)_6]^+ > [Ni(H_2O)_6]^{+2} > [Mn(H_2O)_6]^{+2}$

CSIR JUNE 2012

2. In the reactions (A) and (B),

$n(H_2O) + Cl^- \rightarrow [Cl(H_2O)n]^-$ ….. (A)

$(H_2O)_6 + Mg^{+2} \rightarrow [Mg(H_2O)_6]^{+2}$ ...... (B)

Water behaves as

(a) An acid in both (A) and (B)

(b) An acid in (A) and a base in (B)

(c) A base in (A) an acid in (B)

(d) A base in both (A) and (B)

3. In the following reactions carried out in liquid NH_3

$Zn(NH_2)_2 + 2KNH_2 \rightarrow K_2[Zn(NH_2)_4]$

$K_2[Zn(NH_2)_4] + 2\ NH_4NO_3 \rightarrow Zn(NH_2)_2 + 2\ KNO_3 + 4\ NH_3$

KNH_2 and NH_4NO_3 act respectively as

(a) Solvo-acid and solvo-base

(b) Solvo-base and solvo-acid

(c) Conjugate acid and conjugate base

(d) Conjugate base and conjugate acid

CSIR DEC 2012

4 . Match each item from the List-I (compound in solvent) with that from the List-II (its behaviour) and select the correct combination using the codes given below.

List-I	**List-II**
A. CH_3COOH in pyridine	(i) strong acid..
B. CH_3COOH in H_2SO	(ii) weak acid

C.$HClO_4$ in H_2SO_4	(iii) strong base
D. SbF_5 in HF	(iv) weak base

(a) (A-i), (B-ii), (C-iii), (D-iv)   (b) (A-ii), (B-i), (C-in), (D-iv)

(c) (A-iii), (B-iv), (C-ii), (D-i)   (d) (A-iv), (B-ii), (C-iii), (D-i)

CSIR JUNE 2013

5. The compound that will behave as an acid in H_2SO_4 is

(a) CH_3COOH (b) HNO_3 (c) $HClO_4$ (d) H_2O

CSIR DEC 2013

6. Among the following, the correct acid strength trend is represented by

(a) $[Al(H_2O)_6]^{+3} < [Fe(H_2O)_6]^{+3} < [Fe(H_2O)_6]^{+2}$

(b) $[Fe(H_2O)_6]^{+3} < [Al(H_2O)^6]^{+3} < [Fe(H_2O)_6]^{+2}$

(c) $[Fe (H_2O)_6]^{+2} < [Fe(H_2O)^6]^{+3} < [Al(H_2O)_6]^{+3}$

(d) $[Fe (H_2O)_6]^{+2} < [Al(H_2O)^6]^{+3} < [Fe(H_2O)_6]^{+3}$

CSIR JUNE 2015

7. Match the action of H_2O_2, in aqueous medium given in column A with the oxidation/reduction listed in column B

A: action of H_2O_2	B: type of reaction
(1) Oxidation in acid	(A) $[Fe(CN)_6]^{3-} \rightarrow [Fe(CN)_6]^{4-}$
(II) Oxidation in base	(B) $[Fe(CN)6]4- \rightarrow [Fe(CN)_6]_{3-}$
(III) Reduction in acid	(C) $MnO^{4-} \rightarrow Mn^{2+}$
(IV) Reduction in base	(D) $Mn^{2+} \rightarrow Mn^{4+}$

The correct answer is

(a) I-A, II-B, III-C, IV-D   (b) I-B, II-D ,III-C, IV-A

(c) I-C, II-D, III-B, IV-A   (d) I-D, II-A, III-C, IV-B

8. Water plays different roles in the following reactions.

(i) $2H_2O + Ca \rightarrow Ca^{+2} + 2OH^{-} + H_2$ (ii) $nH_2O + Cl \rightarrow [Cl(H_2O)\ n]^{-}$

(iii) $6H_2O + Mg^{+2} \rightarrow [Mg(H_2O)_6]^{+2}$ (iv) $2H_2O + 2F_2 \rightarrow 4HF + O_2$

The correct role of water in each reaction is,

(a) (i) oxidant, (ii) acid, (iii) base and (iv) reductant

(b) (i) oxidant, (ii) base, (iii) acid and (iv) reductant

(c) (i) acid, (ii) oxidant, (iii) reductant and (iv) base

(d) (i) base, (ii) reductant, (iii) oxidant and (iv) base

CSIR JUNE 2016

9. Which of the following react(s) with AsF_5 in liquid BrF_3 ?

(a) XeF_6 only (b) XeF_6 and XeF_4 (c) XeF_6 and XeF_2 (d) XeF_4 and XeF_2

10. Consider the following reactions:

(A) $NOCl + Sn \underset{\longrightarrow}{N204}$ (B) $NOCl + AgNO_3 \rightarrow$

(C) $NOCl + BrF_3 \rightarrow$ (D) $NOCl + SbCl_5 \rightarrow$

Reactions which will give $[NO]^+$ as a major product are:

(a) A and B (b) C and D (c) A and C (d) B and D

11. Among KF, SnF, and SbF_4 , solute(s) that increase(s) the concentration of BrF_3^{-1} in BrF_3 , is/are

(a) KF only (b) KF and SnF_4

(c) SnF_4 and SbF_5 (d) KF, SnF_4 and SbF_5

CSIR DEC 2016

12. For the reaction,

$HX (aq) + H_2O(l) \overset{\text{gives}}{\longleftrightarrow} H_3O+ + X$the

highest value of $[X^-]$, when X^- is

(a) OCl^- (b) F^{-w} (c) Cl^- (d) NO_2^-

13. Some molecules and their properties in liquid ammonia are given in columns A and B respectively. Match column A with column B

Column A	Column B
(A)Cl_2	(i)Weak acid
(B)S_8	(ii)Strong acid
(C)CH_3CO_2H	(iii)Disproportionation
(D)Urea	(iv)Solvolysis is and disproportionation

The correct match is

(a) (A)- (i); (B)- (i); (C)- (iii); (D)-(iv) (b)(A)-(i); (B)- (iii); (C)- (iv); (D)- (i)

(c) (A)-(iii); (B)-(iv); (C)- (i); (D)- (ii) (d) (A)-(iv); (B)- (iii); (C)-(ii); (D) - (i)

CSIR JUNE 2017

14. The compound that gives a basic solution in HF is :

(a) AsF_5 (b) PF_5 (c) BF_3 (d) BrF_3

15. Match items in column A with items in column B:

Column A	Column B
I.$SbF_5+BrF_3 \rightarrow [BrF_2]^+[SbF_6]^-$	A. Lewis acid behavior of BrF_3
II. $[BrF_2][SbF_6]+Ag[BrF_4] \rightarrow Ag[SbF_6]+2BrF_3$	B. Lewis base behavior of BrF_3
III. $KF+BrF_3 \rightarrow K^+ + [BrF_4]^-$	C. Self-ionization
IV.$3BrF_3 \rightarrow [BrF_2]^+ + [BrF_4]^-$	D. Neutralisation

The correct answer is

(a)1-(A): II-(B); III-(C) IV-(D) (b) I-(B); II-(D); III-(C); IV-(A)

(c) I-(C); II-(D); III-(B); IV-(A) (d) I-(B); II-(D); III-(A); IV-(C)

CSIR DEC 2017

16. The reactions given below,

A $Cl_2 + H_2O \rightarrow HOCl + H_3O^+ + Cl^-$ B $Cl_2 + 2NH_3 \rightarrow NH_2Cl + NH_4 + Cl$

Are examples of

(a) disproportionation only (b) disproportionation (A) and solvation (B)

(c) solvation (A) and disproportionation (B) (d) solvalysis as well as disproportionation

CSIR JUNE 2018

17. The transformation are given in Column 1 and reagent in Column II. Match the items of Column I with those of Column II

Column I	ColumnII
(a)$[MnO_4]^- \rightarrow [MnO_4]^{2-}$	(i)H_2SO_4
(b)$Me_3CH \rightarrow [Me_3C]^+$	(ii)Na in liquid NH_3
(c) $Ag + Au \rightarrow [AuF_4]$	(iii) $[H_2SO_4F]^+$ (super acid)
(d)$H_3PO_4] \rightarrow [P(OH)_4]^+$	(iv) Liquid BrF_3

(a) (a)-(i); (b)-(ii); (c)-(iii); (d)-(iv) (b) (a)-(ii); (b)-(iii); (c)-(iv); (d)-(i)

(c) (a)-(iii); (b)-(ii); (c)-(i); (d) -(iv) (d) (a)-(iii); (b)-(i); (c)-(iv); (d)- (ii)

CSIR DEC 2018

18. Consider compounds PF_5 , SbF_5 , PH_3 and SbH_3 . The strongest acid and the strongest base among these are, respectively

(a) PF_5 and PH_3 (b) SbF_5 and PH_3 (c) SbF_5 and SbH_3 (d) PF_5 and SbH_3

CSIR JUNE 2019

19. The reaction of IO_3^- with I^- in aqueous acidic medium results in

(a) I_2 and H_2O (b) I_2 and H_2O_2 (c) IO^- and H_2O (d) IO^- and H_2O_2

20. Among the following reactions, those that are feasible in liquid NH_3 are

(I) $KNO_3 + AgCl \rightarrow KCl + AgNO_3$

(II) $NH_4Br + KNH_2 \rightarrow KBr + 2NH_3$

(III) $Fe(CO)_5 + 2e^- \rightarrow [Fe(CO)_4]_2^- + CO$

(a) I, II and III (b) I and II only (c) I and III only (d) II and III only

21. The cations formed upon dissolving SnF_4 and AuF_3 in liquid BrF_3 separately, respectively are

(a) SnF_3^+ and BrF_2^+ (b) BrF_2^+ and AuF_2^+ (c) BrF_2^+ only (d) SnF_3^+ and AuF_2^+

CSIR DEC 2019

22. Choose the equilibria from the following that are NOT favoured to go to right

(A) $As_2S_5 + 5HgO \xleftrightarrow{\text{gives}} As_2O_5 + 5\,HgS$

(B) $La_2(CO_3)_3 + Bi_2S_3 \xleftrightarrow{\text{gives}} La_2S_3 + Bi_2(CO_3)_3$

(C) $CaSO_4 + CaS \xleftrightarrow{\text{gives}} CdS + CaSO_4$

(D) $BeF_2 + HgI_2 \xleftrightarrow{\text{gives}} BeI_2 + HgF_2$

(a) A and B (b) A and C (c) B and C (d) B and D

23. Among $SO_2(OH)F$, CH_3CO_2H , LiF and H_2O, the compound(s) which behave(s) as a base in liquid HF is/are

(a) CH_3CO_2H and LiF only
(b) LiF only
(c) $SO_2(OH)F$ and LiF only
(d) CH_3CO_2H , LiF and H_2O

CSIR JUNE 2021

24. Identify the correct statement for the two reactions given below

$$xe + PtF_6 \xrightarrow{SF_6} [Xe]^+[PtF_6]^-$$

$$xeF_4 + Me_4NF \longrightarrow [Me_4N]^+[XeF_5]^-$$

(a) Xe and XeF4 both act as acids.

(b) Xe and XeF4 both act as bases.

(c) Xe acts as an acid and XeF4 acts as a base.

(d) Xe acts as a base and XeF4 acts as an acid.

•••••••

ANSWER KEY

CHEMICAL BONDING

1.	(b)	2.	(c)	3.	(b)	4.	(a)	5.	(b)	6.	(a)	7.	(b)
8.	(c)	9.	(d)	10.	(d)	11.	(d)	12.	(d)	13.	(d)	14.	(c)
15.	(d)	16.	(a)	17.	(c)	18.	(b)	19.	(b)	20.	(c)	21.	(c)
22.	(b)	23.	(b)	24.	(c)	25.	(a)	26.	(a,c)	27.	(a)	28.	(b)
29.	(c)	30.	(a)	31.	(b)	32.	(c)	33.	(c)	34.	(d)	35.	(b)
36.	(b)	37.	(c)	38.	(c)	39.	(c)	40.	(a)	41.	(a)	42.	(a)
43.	(d)	44.	(a)	45.	(b)	46.	(a)	47.	(b)	48.	(c)	49.	(d)
50.	(c)	51.	(c)	52.	(a)	53.	(b)	54.	(d)	55.	(a)	56.	(a)
57.	(d)	58.	(c)	59.	(b)	60.	(c)	61.	(a)	62.	(c)	63.	(c)
64.	(a)	65.	(a)										

9

Bioinorganic Chemistry

CSIRJUNE 2011

1. The ligand system present in vitamin B_{12} is:

(a) Porphyrin (b) Corrin (c) Phthalocyanine (d) Crown ether

2. Carboxypeptidase contains:

(a) Zn (II) and hydrolyses CO_2 (b) Zn (II) and hydrolyses peptide bonds

(c) Mg (II) and hydrolyses CO_2 (d) Mg (II) and hydrolyses peptide bonds

CSIR DEC 2011

3. Superoxide dismutase contains the metal ions

(a) Zn (II) and Ni(II) (b) Cu(II) and Zn(II)

(c) Ni (II) and Co(III) (d) Cu (II) and Fe(III)

4. Among the following drugs, the anticancer agents is:

(a) captopril (b) chloroquine

(c) camptothecin (d) ranitidine

5. The reduction of nitrogen to ammonia, carried out by the enzyme nitrogenase, needs,

(a) 2 electrons (b) 4 electrons (c) 6 electrons (d) 8 elecrons

6. A metal ion that replace manganese (II) ion in mangano-proteins without changing its function, is

(a) Fe (II) (b) Zn (II) (c) Mg (II) (d) Cu (II)

7. In the bacterial rubredoxin, the number of iron atoms, sulfur bridges and cysteine ligands are

	Fe atom	Sulfur bridge	Cysteine
(a)	4	4	4
(b)	2	2	4
(c)	2	2	2
(d)	1	0	4

CSIR JUNE 2012

8. The oxidation state of iron in met-hemoglobin is

(a) Three (b) Two (c) Four (d) Zero

9. The changes (from A-D given below) which occur when O_2 binds to hemerythrin are

(A) One iron atoms is oxidized

(B) Both the iron atoms are oxidized

(C) O_2 binds to one iron atom and is also hydrogen bonded.

(D) O_2 binds to both the iron atoms and is also hydrogen bonded.

(a) B and C (b) B and D (c) A and D (d) A and C

10. In the photosynthetic systems the redox metalloproteins involved in electron transfer are cytochrome (cyt, b), cytochrome bf complex (cyt bf) and plastocyanin (PC). The pathway of electron flow is

(a) PC → cyt b→ cyt bf (b) cyt bf→ cyt b→ PC

(c) cyt b→ cyt bf →PC (d) PC→ cyt bf→ cyt b

CSIR DEC 2012

11. The correct set of the biologically essential elements is,

(a) Fe, Mo, Cu, Zn (b) Fe, Cu, Co, Ru (c) Cu, Mn, Zn, Ag (d) Fe, Ru, Zn, Mg

12. Based on the behaviour of the metalloenzymes, consider the following statements

(A) In the enzymes, the zinc activates O_2 , to form peroxide species.

(B) In the enzymes, the zinc activates H_2O and provides a zinc boud hydroxide.

(C) In the oxidases, the iron activates O_2, to break the bonding between the two oxygens

(D) Zinc ion acts as a nucleophile and attacks at the peptide carbonyl

The set of correct statements is,

(a) A and B (b) B and C (c) C and D (d) A and D

13. Fe^{+2}-porphyrins fail to exhibit reversible oxygen transport and cannot differentiate CO from O_2. However, the hemoglobin is free from both these pit falls. Among the following

(A) Fe^{+2} -porphyrins undergo μ -oxodimer formation and the same is prevented in case of the hemoglobin.

(B) Fe-CO bond strength is much low in case of hemoglobin when compared to the Fe^{+2} porphyrins.

(C) While Fe-CO is linear, Fe-O_2 is bent and is recognized by hemoglobin

(D) The interlinked four monomeric units in the hemoglobin are responsible to overcome the pitfalls.

The correct set of statements is

(a) A and B (b) A and C (c) C and D (d) B and D

CSIR JUNE 2013

14. The coordination geometry of copper (II) in the type I copper protein plastocyanin is:

(a) square planar (b) tetrahedral (c) octahedral (d) distorted tetrahedral

15. The metal ions present in the active site of nitrogenase enzyme co-factor are

(a) Fe, Mo (b) Fe, W (c) Fe, Cu (d) Fe, Ni

16. For the metalloprotein hemerythrin, the statement that NOT TRUE is

(a) there are two ion centres per active site.

(b) both iron centres are hexacoordinated in the active state.

(c) one iron is hexacoordinated while the other is pentacoordinated in the active state.

(d) it is found in marine invertebrates.

CSIR DEC 2013

17. Patients suffering from Wilson's disease have

(a) Low level of Cu-Zn superoxide dismutase

(b) High level of Cu-Zn superoxide dismutase

(c) Low level of copper-storage protein, ceruloplasmin

(d) High level of copper-storage protein, ceruloplasmin

18. High dose of dietary supplement $ZnSO_4$, for the cure of Zn deficiency

(a) reduces myoglobin

(b) increases iron level in blood

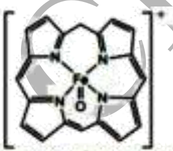
(c) increases copper level in brain

(d) reduces copper, iron and calcium levels in body

19. L-DOPA is used for treatment of

(a) tuberculosis (b) Parkinson’s disease (c) diabetes (d) cancer

20. Oxidised form of enzyme catalase (structure A); prepared by the reaction of $[Fe(P)]^+$ (P = porphyrin) with H_2O_2 has green color because



A(substitutents on ring are removed for clarity)

(a) Oxidation state of iron changed from Fe^{III} to Fe^{IV}

(b) Porphyrin ring is oxidized by one electron

(c) $\pi-\pi^*$ transition appears in the visible region

(d) Fe^{IV} is coordinated with anionic tyrosinate ligand in axial position.

CSIR JUNE 2014

21. If an enzyme fixes N_2, in plants by evolving H_2, the number of electrons and protons associated with that, respectively are

(a) 6 and 6 (b) 8 and 8 (c) 6 and 8 (d) 8 and 6

22. Ozone present in upper atmosphere protects people on the earth

(a) due to its diamagnetic nature

(b) due to its blue colour

(c) due to absorption of radiation of wavelength at 255nm

(d) by destroying chlorofluoro carbons

23. Molybdoenzymes can both oxidize as well as reduce the substrates, because

(a) Mo(VI) is more stable than Mo(IV)

(b) Mo(IV) can transfer oxygen atom to the substrate and Mo(VI) can abstract oxygen atom from the substrate

(c) Conversion of Mo(VI) to Mo(IV) is not favoured

(d) Mo(VI) can transfer oxygen atom to the substrate and Mo(IV) can abstract oxygen atom from the substrate.

24. The cooperative binding of O2 in hemoglobin is due to

(a) a decrease in size of iron followed by changes in the protein conformation

(b) an increase in size of iron followed by changes in the protein conformation

(c) a decrease in size of iron that is NOT accompanied by the protein conformational changes

(d) an increase in size of iron that is NOT accompanied by the protein conformational changes

CSIR DEC 2014

25. The extent of π-electron conjugation in macrocyclic rings of (1) heme, (2) coenzyme B_{12} and (3) chlorophyll follows the order

(a) (1) > (3) >(2) (b) (1) > (2) > (3) (c) (3) > (1) > (2) (d) (2) > (1) > (3)

26. The number of histidine amino acid nitrogen atoms coordinated to bimetallic active site of oxyhemocyanin, and oxyhemerythrin, respectively, are

(a) 2, 3 and 3, 3. (b) 3, 3 and 2, 3 (c) 3, 3 and 2, 2 (d) 2, 4 and 3,2

27. Identify correct statements for mercury as an environment pollutant.

A. Carbanionicbiomethylation converts it to $MeHg^+$

B. Thiol group of cysteine has strong affinity for mercury

C. Mercury containing industrial catalyst release caused Minamata disaster

The correct answer is:

(a) A and B (b) A and C (c) B and C (d) A, B and C

28. Under physiological condition, oxygen is binding to deoxyhemoglobin and deoxymyoglobin, the binding curve and its pH dependence, respectively, are

(a) Sigmoidal and pH dependent; hyperbolic and pH independent

(b) Hyperbolic and pH independent:sigmoidal and pH dependent

(C) Sigmoidal and pH independent;hyperbolic and pH dependent

(d) Hyperbolic and pH dependent:sigmoidal and pH independent

29. Match the metalloproteins in Column-A with their function in Column-B

Column-A	**Column-B**
I. Oxyhemocyanin	A. hydrolysis of C-terminal peptide bond
II. Carbonic anhydrase	B. Methylation
III. Cytochrome P_{450}	C. Conversion of CO_2 to H_2CO_3
IV. Carboxy-peptidase A	D. Oxdiation of alkene
E. oxygen storage	
F. oxygen transport	

The correct answer is

(a) I-F: II-C; III - D; IV-A   (c) I-F; II-B; III - C; IV-A

(b) I-E: II-C; III-A; IV-F   (d) 1-E; II-D; III-C; IV-A

CSIR JUNE 2015

30. The biological functions of carbonic anhydrase and carboxypeptidase A, respectively, are

(a) interconversion of CO_2 and carbonates and hydrolysis of peptide bond

(b) gene regulation and interconversion of CO_2 and carbonates

(c) gene regulation and hydrolysis of peptide bond

(d) interconversion of CO_2 and carbonates and gene regulation

31. The Fe-Nporphyrin bond distances in the deoxy and oxy-hemoglobin, respectively, are

(a) 2.1 and 2.0Å   (b) 2.0 and 2.0 Å

(c) 2.2 and 2.3Å   (d) 2.3 and 2.5Å

32. The total number of metal ions and the number of coordinated imidazole units of histidine in the active site of oxy-hemocyanin, respectively, are

(a) 2Cu and 6   (b) 2Fe and 5   (c) 2Cu and 6   (d) Fe and 3

CSIR DEC 2015

33. The biological functions of cytochrome P_{450} and myoglobin are, respectively

(a) oxidation of alkene and O_2 storage   (b) O_4 transport and O_2 storage

(c) O_2 storage and electron carrier   (d) electron carrier and O_2 transport

34. Deoxy-hemocyanin is

(a) heme protein and paramagnetic   (b) colourless and diamagnetic

(c) O_2 transporter and paramagnetic   (d) blue colored and diamagnetic

35. The resonance Raman stretching frequency ($^{\nu}$ o-o. in cm^{-1}) of O_2, is 1580. The $^{\nu}$ o-o for O_2 in bound oxy-hemoglobin is close to

(a) 1600   (b) 1900   (c) 800   (d) 1100

36. Match the metalloprotein in Column-A with its biological function and metal centre in Column-B

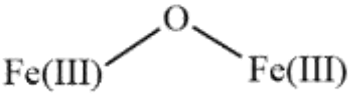
Column-A	**Column-B**
(A) hemoglobin	(I) electron carrier and iron
(B) cytochrome b	(II) electron carrier and copper
(C) vitamin B12	(III) O_2 transport and copper
(D) hemocyain	(IV) Group transfer reactions and cobalt
	(V) O_2 storage and cobalt
	(VI) O_2 transport and iro

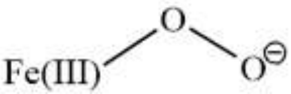
The correct match is

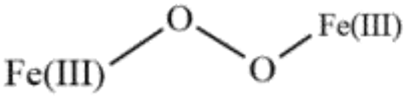
(a) A-VI, B-I, C-IV and D-III
(b) A-V. B-I, C-IV and D-III
(c) A-VI. B-V, C-I and D-II
(d) A-V, B-VI, C-II and D-IV

CSIR JUNE 2016

37. In the absence of bound globin chain, heme group on exposure to O_2 gives the iron-oxygen species

(a) 

(b) 

(c) 

(d) Fe(IV) = O

38. Match the metal given in Column-A with its medicinal use as a compound in Column-B

Column-A	Column-B
(A) Gd	(I) Cancer
(B) Au	(II) Maniac depression
(C) Pt	(III) MRI contrast agent
(D) Li	(IV) Arthritis

Correct match is

(a) A-II: B-III; C-IV: D-I
(c) A-III; B-IV; C-I; D-II
(b) A-IV; B-II: C-I, D-III
(d) A-I; B-II: C-III; D-IV

39. Correct combination of number and size of rings present in a metal ion-porphine complex (including metal ion bearing chelate rings) is

(a) four 5-membered and four 6-membered

(b) two 5-membered and six 6-membered

(c) six 5-membered and two 6-membered

(d) five 5-membered and three 6-membered

40. In human body cis- platinhydrolyzes to diaqua complex and modifies the DNA structure by binding to

(a) N-atom of guanine base (b) N-atom of adenine base

(c) O-atom of cytosine base (d) O-atom of thymine base

CSIR DEC 2016

41. In the catalytic hydration of CO_2 by carbonic anhydrase, CO_2 first interacts with

(a) OH group of the active site of the enzyme and then with zinc

(b) H_2O of the active site of the enzyme and then with zinc

(c) zinc of the active site of the enzyme and then with OH group

(d) zinc of the active site of the enzyme and then with H_2O

42. The number of inorganic Sulphur (or sulphide) atoms present in the metalloprotein active sites ofrubredoxin, 2-iron ferredoxin and 4-iron ferredoxin, respectively, are

(a) 0, 2 and 4 (b) 2, 4 and 3 (c) 0, 4 and 2 (d) 0, 2 and 3

43. From the following transformations,

A. Epoxidation of alkene

B. Dioldehydrase reaction

C. Conversion of ribonucleotide-to-deoxyribonucleotide

D. 1, 2-carbon shift in organic substrates those promoted by coenzyme B_{12} are

(a) A and B (b) B, C and D (c) A , B and D (d) A, B and C

44. Match the items in Column A with the appropriate items in Column B

Column A	**Column B**
a. Metallothioneins	i. Cis –$[Pd(NH_3)_2Cl_2]$
b. Plastocyanin	ii. Cysteine rich protein
c. Ferritin	iii. Electron Transfer
d. Chemotherapy	iv. Iron Transport
	v. Iron Storage
	vi. Carboplatin

The correct answer is

(a) (A) - (i); (B) - (iii); (C) - (v); (D) - (iv) (b) (A) - (i); (B) - (iii); (C) - (iv); (D) - (i)

(c) (A) - (i); (B) - (iii); (C) - (v); (D) - (vi) (d) (A) - (iii); (B) - (v); (C) - (vi); (D) - (ii)

45 . Match the species in column X with their properties in column Y

Column-X	**Column-Y**
(1) Heme A	(i) oxo-bridged, Mn4 cluster
(2) Water splitting enzyme	(ii) tetragonal elongation
(3) $[Mn(H_2O)_6]^{+2}$	(iii) Predominantly, $\pi \rightarrow \pi^*$, electronic transitions
(4) $[Cr(H_2O)_6]^{+2}$	(iv) $d \rightarrow d$ spin-forbidden transitions

(v) tetragonal compression

The correct answer is

(a) (1)-(iii), (2)-(i), (3)-(v), (4)-(ii) (b) (1)-(iii), (2)-(i), (3)-(iv), (4)-(ii)

(c) (1)-(v), (2)-(iii), (3)-(iv), (4)-(ii) (d) (1)-(iii), (2)-(i), (3)-(iv), (4)-(v)

CSIR JUNE 2017

46. The resonance Raman stretching frequencies (in cm-1) of the bound O2 species in oxyhemerthyrin and oxy-hemoglobin, respectively, are

(a) 850 and 1100 (b) 750 and 850 (c) 850 and 850 (d) 1100 and 850

47. In vitro reaction of an excess of O2 with free heme B in aqueous medium the end product is

(a) hematin

(b)[O_2--Fe(III)-protoporphyrin-IX]

(c) heme B(O_2)

(d)oxoferrylprotoporphyrin-IX cation radical

48. Consider the following statements for metallothioneins:

A. the contain about 30% cysteine residues

B. they prefer to bind soft metal ions such as Cd(II), Hg(II) and Zn(II)

C. they are involved in electron transfer reactions

D. they are low molecular weight proteins

Correct statements are

(a) A, B and C (b) A, B and D (c) A, C and D (d) B and C

49. Consider the following statements for deoxy-hemerythrin and deoxy-hemocyanin:

A. they are involved in O2 transport in biological systems

B. they contain two metal ions in their active site

C. active site metal centres are bridged by amino acid residues

D. they prefer to bind only one O_2 per active site

The correct statements are

(a) A, B and D (b) A, C and D

(c) B, C and D (d) A and C

CSIR DEC 2017

50. The correct statement for cytochrome c is

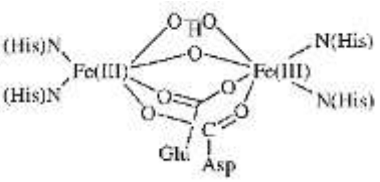
(a) It is a non-heme protein

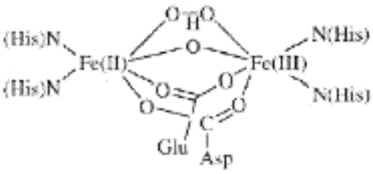
(b) The coordination number of iron in cytochrome c is five

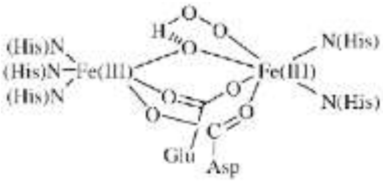
(c) It is a redox protein and an electron carrier

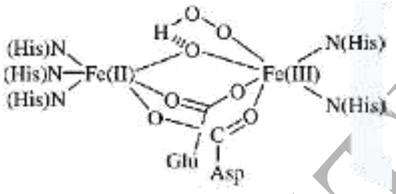
(d) It can store or carry dioxygen

51. The active site structure for oxy-hemerythrin is:

(a)


(b)


(c)


(d)


52. The number of inorganic sulfides in cubane like ferredoxin and their removal method, respectively, are

(a) eight and washing with an acid (b) four and washing with a base

(c) eight and washing with a base (d) four and washing with an acid

CSIR JUNE 2018

53. For the catalytic activity of Cu and Zn containing enzyme, superoxide dismutase. What is /are the correct statement (S)?

(A) Cu and Zn both are essential

(B) Only Cu is essential

(C) Zu is essential and Cu may be replaced by any other divalent metal atom

(D) Zn may be replaced by any other divalent metal atom

(a) (A) only (b) (C) Only (c) (D) Only (d). (B) and (D)

54. Consider the following statements for the oxygenation of hemocyanine:

(A) Oxidation state of both copper atoms changes by two

(B) It becomes intense blue from colorless

(C) Dioxygen is reduced to O_2^{-2}

(D) The μ-η 2 : η 2 bond forms between each oxygen and copper atoms.

The correct statements are:

(a) (A) and (C) (b) (B) and (C) (c) (A), (B) and (C) (d). (B), (C) and (D)

55. Choose the correct set of statements for cis-platin.

(A) It can be prepared from $K_2[PtCl_4]$.

(B) It can be prepared from $[Pt(NH_3)_4Cl_2$.

(C) In its preparation, the observed trans effect for Cl^- is greater than that of NH_3

(D) In blood it stays in equilibrium with cis-$[Pt(NH_3)_2Cl(H_2O)]^+$

(E) In DNA strand, it binds to two adjacent cytosine bases.

The correct set is

(a) A, C and D (b) A, C, D and E (c) B, C and D (d) B, C, D and E

CSIR DEC 2018

56. The chelate rings made by macrocyclic ligand in vitamin B_{12} are

(a) One five-membered and three six-membered

(b) Two five-membered and two six-membered

(c) Three five-membered and one six-membered

(d) Four six-membered

57. Match the items given below in the three columns:

Metalloprotein	**Species coordinated to metal centre(s)**		**Resonance Raman O–O stretching frequency (cm^{-1})**	
(A) Oxymyoglobin	(I)	$\eta^2 : \eta^2 - O_2^{2-}$	(X)	844
(B) Oxyhemocyanin	(II)	HO_2^-	(Y)	803
(C) Oxyhemerythrin	(III)	O_2^-	(Z)	1105

Correct matches:

(a) A-III-Z, B-I-Y, C-II-X
(b) A-II-Y, B-I-X, C-III-Z
(c) A-III-Y, B-I-Z, C-II-X
(d) A-I-X, B-II-Y, C-III-Z

CSIR JUNE 2019

58. The metal transferred by bacteria and fungi using siderophores/siderochromes is

(a) Mo (b) Cu (c) Fe (d) Zn

59. The correct match for the compounds in Column-I with the property in Column-II is

Column-1	**Column-II**
(P) Dichlorodifluoromethane	(I) Anti-inflammatory
(Q) Sulfadiazine	(II) Insecticidal
(R) Cortisone	(III) Antibacterial
(S) Hexachlorobenzene	(IV) Ozone layer depletion

(a) P-11, Q-I, R-IV, S-III
(c) P-I, Q-III, R-II, S-IV
(b) P-IV, Q-1, R-II, S-III
(d) P-IV, Q-III, R-I, S-II

60. Consider the following statements with respect to Cytochrome P-450

(A) It has histidine coordinated to iron centre

(B) It is a membrane bound metalloenzymes

(C) It has Fe(III) ion in the resting state of the enzyme

The correct statement(s) is/are

(a) A, B (b) A, C (c) B, C (d) A only

61. Consider the following transformation, reactions in the context of co-enzyme B_{12}

(A) 1, 2-Carbon shift (B) Hydration of CO_2

(C) Benzene to phenol (D) dimethylsulfide to demethylsulfoxide

The correct statement(s) for co-enzyme B_{12} is/are

(a) A, C, D (b) A, B only (d) A only (c) B, C only

CSIR DEC 2019

62. Choose the correct statements for oxymyoglobin and cytochrome P450 (resting state) from the following:

A. Both contain dianion of protoporphyrin-IX

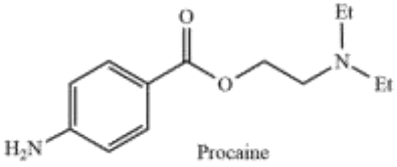
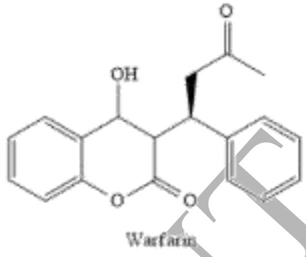
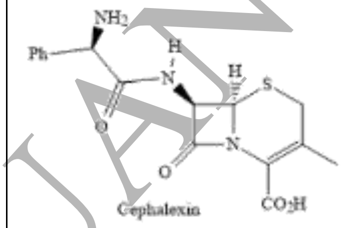
B. They have same fifth-ligand bonded to metal centre from the protein backbone

C. They contain single active site

D. They contain metal ion in +3 oxidation state

(a)A. B and C (b) A, C and D (c) A. B and D (d) B and C only

63. The correct match for the drug molecules in the Column A with their medicinal use in Column B is

	Column A		Column B
P		(i)	Anaesthetic
Q		(ii)	Anticoagulant
R	 NH₂ Ph H N H S O N O Cephalexin CO₂H	(iii)	Antibiotic

(a) P-i; Q-ii; R-iii (b) P-ii; Q-i; R-iii (c)P-iii; Q-i; R-ii (d)P-i; Q-iii; R-ii

64. Complex(es) which has/have unpaired electron(s) that is equal to that of iron center in oxymyoglobin is/are

A $[Fe(ox)_3]^{3-}$ B. $[Fe(CN)_6]^{3-}$ C. $[NiCl_4]^{2-}$ D. $[Cu(NH_3)_4]^{2+}$

(Given: ox oxalato) Correct answer is

(a) A and B (b) B and D (c) C only (d) C and D

65. Match Column I , II and III

Column I (Metal)		Colum II (Enzyme)		Column III (End Product)	
A.	Ni	(i)	Carbonic anhydrase	X	Uric Acid
B.	Zn	(ii)	Xanthine oxidase	Y	Merthane
C.	Mo	(iii)	Coenzyme F_{430}	Z	Carbonic acid

The correct match is

(a) A-iii-Y, B-i-Z ,C-ii-X (b) A-iii-Y, B-ii-X, C-i-Z

(c) A-ii-X, B-i-Y, C-iii-Z (d) A-i-X, B-iii-Z, C-ii-Y

CSIR 2020

66. During the binding of O_2 to myoglobin (consider 'heme' in xy-plane), the molecular orbital of O_2 and atomic orbital of Fe involved in the formation of the ϭ-bond is

(a) π* and d_{z^2} (b) π* and d_{xz} (c) π and d_{xz} (d) π and dz^2

67. In the catalytic cycle of Cytochrome P450 , the generation of [(porphyrin) + FeIV(O)] from [(porphyrin)FeIII(OOH)] involves

(a) One electron oxidation of [(porphyrin)FeIII(OOH)]

(b)Formation of the intermediate [(porphyrin)FeIV(OH)]

(c) Homolytic O-O cleavage of [(porphyrin)FeIV(OOH)]

(d) Heterolytic O-O cleavage of [(porphyrin)FeIII(OOH)]

CSIR JUNE 2021

68. Match the items of column I with the applications given in column II

Column I		Column II	
a.	Zeolite	i.	Solar Cell
b.	Indium tin Oxide	ii.	CO_2capture
c.	$LiCOO_2$	iii.	Fuel Cell
d.	Pt alloy	iv.	Battery

(a) a–iii; b–iv; c–i; d–ii (b) a–i; b–iii; c–ii; d–iv

(c) a–ii; b–i; c–iv; d–iii (d) a–iv; b–ii; c–iii; d–i

69. Match the iron and copper proteins with biological function in the table below:

Iron protein		Copper protein		Biological function	
A	Hemerythrin	i	Azurin	X	Oxygenase
B	Cytochrome P450	ii	Hemocyanin	Y	Electron transfer
C	Rieske protein	iii	Tyrosinase	Z	O_2 transport

The correct matches are

(a) A-ii-Z, B-iii-X,C-i-Y (b) A-ii-Z, B-i-X, C-iii-Y

(c) A-iii-Y, B-i-Z,C-ii-X (d) A-i-Y, B-iii-Z, C-ii-X

70. In 3-iron ferredoxins, the number of sulfide bridges and cysteinyl ligands, respectively, are:

(a) 3, 3 (b) 4, 3 (c) 3, 4 (d) 4, 4

71. Which of the following statements for rubredoxin,

A. F_2^+center has a tetrahedral geometry.

B. Reduced form of iron is diamagnetic.

C. F_2^+ center undergoes Jahn-Teller distortion.

D. It is a [2Fe–2S] cluster. are correct?

(a) A, B and C (b) A, C and D (c) C and D only (d) A and C only

•••••••

ANSWER KEY

BIOINORGANIC CHEMISTRY

1.	(b)	2.	(b)	3.	(b)	4.	(c)	5.	(d)	6.	(c)	7.	(d)
8.	(a)	9.	(a)	10.	(c)	11.	(a)	12.	(b)	13.	(b)	14.	(d)
15.	(a)	16.	(b)	17.	(c)	18.	(d)	19.	(b)	20.	(a)	21.	(b)
22.	(c)	23.	(d)	24.	(a)	25.	(a)	26.	(b)	27.	(d)	28.	(a)
29.	(a)	30.	(a)	31.	(a)	32.	(a)	33.	(a)	34.	(b)	35.	(d)
36.	(a)	37.	(a)	38.	(c)	39.	(a)	40.	(a)	41.	(a)	42.	(a)
43.	(b)	44.	(c)	45.	(b)	46.	(a)	47.	(a)	48.	(b)	49.	(a)
50.	(c)	51.	(c)	52.	(d)	53.	(d)	54.	(d)	55.	(a)	56.	(a)
57.	(a)	58.	(c)	59.	(d)	60.	(c)	61.	(d)	62.	(b)	63.	(a)
64.	(b)	65.	(a)	66.	(a)	67.	(d)	68.	(c)	69.	(a)	70.	(a)
71.	(d)												

QUANTA
CHEMISTRY CLASSES

10

ANALYTICAL CHEMISTRY

CSIR JUNE 2011

1. Correct statement for 'Inductively Coupled Plasma Atomic Emission Spectroscopy' is
   (a) It is unsuitable for all non-metals.
   (b) Simultaneous determination of only metals is possible.
   (c) Induction coil stabilizes plasma.
   (d) Oxide formation lowers atomization of metal.
2. Thermometric titration gives best results when
   A. $|\Delta H|$ is high
   B. $\Delta G < 0$
   C. Heat of mixing of titrant with titrant is high
   D. Titrant is used as dilute solution
   The answer is
   1. A and B　　2. B and C　　3. C and D　　4. A and D

CSIR DEC 2019

3. The pair of light source and atomizer resulting highest sensitivity to atomic absorption spectrometric measurement is:
   (a) Hg lamp, nitric oxide flame
   (b) Hg lamp, graphite furnace
   (c) Hollow cathode lamp, graphite furnace
   (d) Hollow cathode lamp; acetylene-nitric oxide flame
4. Inspectrofluorimetric determination in solution
   A. absorbance of analyte solution is kept near to 0.05
   B. oxygen is eradicated from solution
   C. pH of solution is controlled

]

   D. wavelength of incident light is always above 400 nm

Correct from the above is

(a) A, B and D (b) B, C and D (c) A, B and C (d) A, C and D

5. Match the items in column I with those of column II

Column I	Column II
a. Conductometirc titration	i. Voltage
b. Amperometric titrations	ii. Resistance
c. pH metric titration	iii. ΔI
d. Differential pulse polarography	iv. I_d

Correct match is

(a) a-ii; b-iv, c-i, d-iii (b) a-iii; b-i; e-ii; d-iv.

(c) a-iii; b-ii; c-iv, d-i (d) a-i; b-iii; e-iv, d-ii

CSIR JUNE 2019

6. The role of H_3PO_4 in the estimation of Fe (II) with $K_2Cr_2O_7$ using diphenylamine sulphonate as ndicator is to

(a) avoid aerial oxidation of Fe(II) (b) reduce the electrode potential of Fe^{+3} –Fe^{+3}

(c) stabilize the indicator (d) stabilize $K_2Cr_2O_7$

7. Incorrect statement for amperometric titration is

(a) it is based on measurement of diffusion current.

(b) its sensitivity is always higher than those of spectrophotometric titrations

(c) it does not generally require an indicator

(d) it requires inert atmosphere (N_2 /Ar)

CSIR DEC 2018

8. Match the items of Column I with those of Column II.

Column-I	Column II
(A) Laser source	(I) Electron Capture Detector
(B) Thermometric titration	(II) Polarography
(C) Gelatin	(III) Heat of reaction
(D) Gas-liquid chromatography	(IV) Spectrofluorimetry

Correct answer is:

(a) a-iv; b-iii; c-ii; d-I (b) a-i: b-iii; c-ii; d-iv

(c) a-iv; b-ii; c-iii; d-I (d) a-iii; b-ii; c-iv; d-i

CSIR JUNE 2018

9. Height equivalent to theoretical plate (HETP) in gas liquid chromatography depends Significantly on which of the following?

(A) Temperature of column (B) Velocity of carrier gas

(C) Packing of column (D) Column material

(a) A, B and C (b) C and D (c) B, C and D (d) A and C

CSIR DEC 2017

10. To determine the bond parameters at 25°C, electron diffraction is generally unsuitable for both

(a) O_3 and NO_2 (b) Sulfur and dry ice

(c) NO_2 and sulphur (d) O_3 and dry ice

11. Spectrophotometric monitoring is not suitable to determine the end point of titration of:

(a) oxalic acid vs potassium permanganate (b) iron(II) vs 1, 10-phenanthroline

(c) cobalt(II) vseriochrome black T (d) nickel (II) vsdimethylglyoxime

12. The peak area of differential thermal analysis curve is proportional to one or more of the following

A. mass loss B. mass of the sample C. heat of decomposition / phase change

The correct answer is:

(a) A only (b) B only (c) A and C (d) B and C

CSIR JUNE 2017

13. Identify the correct statement(s) for phosphorimetric measurement from the following:

A. It is done after a time delay when fluorescence, if present becomes negligible

B. Immobilization of analyte increases phosphorescence.

C. Phosphorescence decreases in the presence of heavy atoms

(a) A only (b) A and B (c) A and C (d) Band C

14. Identify correct statements from the following:

A. Area of differential thermal analysis peak is proportional to amount of sample.

B. Area of differential thermogravimetric analysis curve is proportional to mass loss.

C. Phase transition cannot be studied , with differential scanning calorimetry.

D. Simultaneous determination of two metal ions is possible with thermogravimetric analysis.

(a) A, B and C (b) A, B and D (c) B, C and D (d) A, C and D

CSIR DEC 2016

15. The primary analytical method (not using a reference) is:

(a) inductively coupled plasma emission spectrometry

(b) energy dispersive X-ray fluorescence spectrometry

(c) anodic stripping voltammetry

(d) isotopic dilution mass spectrometry

CSIR JUNE 2016

16. Decomposition temperature of $CaCO_3$ in thermogravimetric analysis will be highest in dynamic atmosphere of:

(a) nitrogen
(b) synthesis gas
(c) 1 : 1 mixture of O_2 and CO
(d) water gas.

CSIR DEC 2015

17. Correct statement for coulometry is

(a) it is based on Faraday's law of electrolysis
(b) It is a type of voltammetry
(c) it is based on Ohm's law
(d) it uses ion selective electrode

18. Pick the correct statements about Atomic Absorption Spectrometry (AAS) from the following:

A. Hg lamp is not a suitable source for AAS
B. Graphite furnace is the best atomizer for AAS
C. Non-metals cannot be determined with AAS
D. AAS is better than ICP-AES for simultaneous determination of metal Ions.

(a) A, B and C
(b) B, C and D
(c) C, D and A
(d) D, A and B

19. The calibration curve in spectrofluorimetric analysis becomes non-linear when

(a) molecular weight of analyte is high
(b) intensity of light source is high
(c) concentration of analyte is high
(d) molar absorptivity of analyte is high

CSIR JUNE 2015

20. Differential pulse polarography (DPP) is more sensitive than D.C. Polarography (DCP). Consider following reasons for it:

1. Non-faradic current is less in DPP in comparison to DCP
2. Non-faradic current is more in DPP in comparison to DCP
3. Polarogram of DPP is of different shape than that of DCP

Correct reason(s) is/are:

(a) 1 and 3
(b) 2 and 3
(c) 2 only
(d) 1 only

21. Considering the following parameters with reference to the fluorescence of a solution:

1. Molar absorptivity of fluorescent molecule
2. Intensity of light source used for excitation
3. Dissolved oxygen

The correct answer for the enhancement of fluorescence with the increase in these parameters is/are

(a) 1 and 2 (b) 2 and 3 (c) 1 and 3 (d) 3 only

CSIR DEC 2014

22. The gas commonly used in generating plasma in Inductively Coupled Plasma Atomic Emission Spectroscopy (ICPAES) is:

(a) Argon (b) Carbon dioxide (c) Nitrous oxide (d) hydrogen

23. Gel permeantion chromatography can be used to separate which of the following:

(A) Lanthanides (B) Alkaline earths

(C) Fatty acids (D) Low molecular weight peptides

The correct answer is

(a) A and B (b) B and C (c) C and D (d) A and D

CSIR JUNE 2014

24. The use of dynamic inert atmosphere in thermogravimetric analysis (TGA):

(a) decreases decomposition temperature (b) decrease weight loss

(c) reduces rate of decomposition (d) increases weight loss

25. The correct statements for hollow cathode lamp (HCL) from the following are:

(A) HCL is suitable for atomic absorption spectroscopy (AAS)

(B) lines emitted from HCL are very narrow

(C) the hardening of lamp makes it unsuitable for AAS

(D) transition elements used in lamps have short life

(a) A, B and C (b) B, C and D (c) C, D and A (d) D, A and B

CSIR DEC 2013

26. In the atomic absorption spectroscopic estimation of Fe(III) using O_2 / H_2 flame, the absorbance decreases with the addition of

(a) CO_3^{+2} (b) SO_4^{2-}

(c) EDTA (d) Cl^-

CSIR JUNE 2011

27. The FALSE statement for a polarographic measurement procedure is:

(a) O_2 is removed

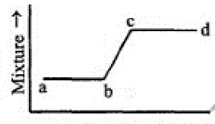
(b) Dropping mercury electrode is working electrode.

(c) Id is proportional to concentration of electro active species.

(d) Residual current is made zero by adding supporting electrolyte

CSIR JUNE 2012

28. The spectrophotometric response for the titration of a mixture of Fe^{+3} and Cu^{+2} ions against EDTA is given below.



The correct statment is:

(a) Volume ab = [Fe^{+3}] and volume cd= [Cu^{+2}]

(b) Volume ab = [Cu^{+2}] and volume cd = [Fe^{+3}]

(c) Volume ab = [Fe^{+3}] and volume ab = excess EDTA

(d) Volume ab = [Cu^{+2}] and volume cd = excess EDTA

•••••••

ANSWER KEY

ANALYTICAL CHEMISTRY

1.	(c)	2.	(a)	3.	(c)	4.	(c)	5.	(a)	6.	(b)	7.	(d)
8.	(a)	9.	(a)	10.	(b)	11.	(c)	12.	(d)	13.	(b)	14.	(b)
15.	(d)	16.	(c)	17.	(a)	18.	(a)	19.	(a)	20.	(d)	21.	(a)
22.	(a)	23.	(c)	24.	(d)	25.	(a)	26.	(b)	27.	(d)	28.	(c)

QUANTA CHEMISTRY
CLASSES